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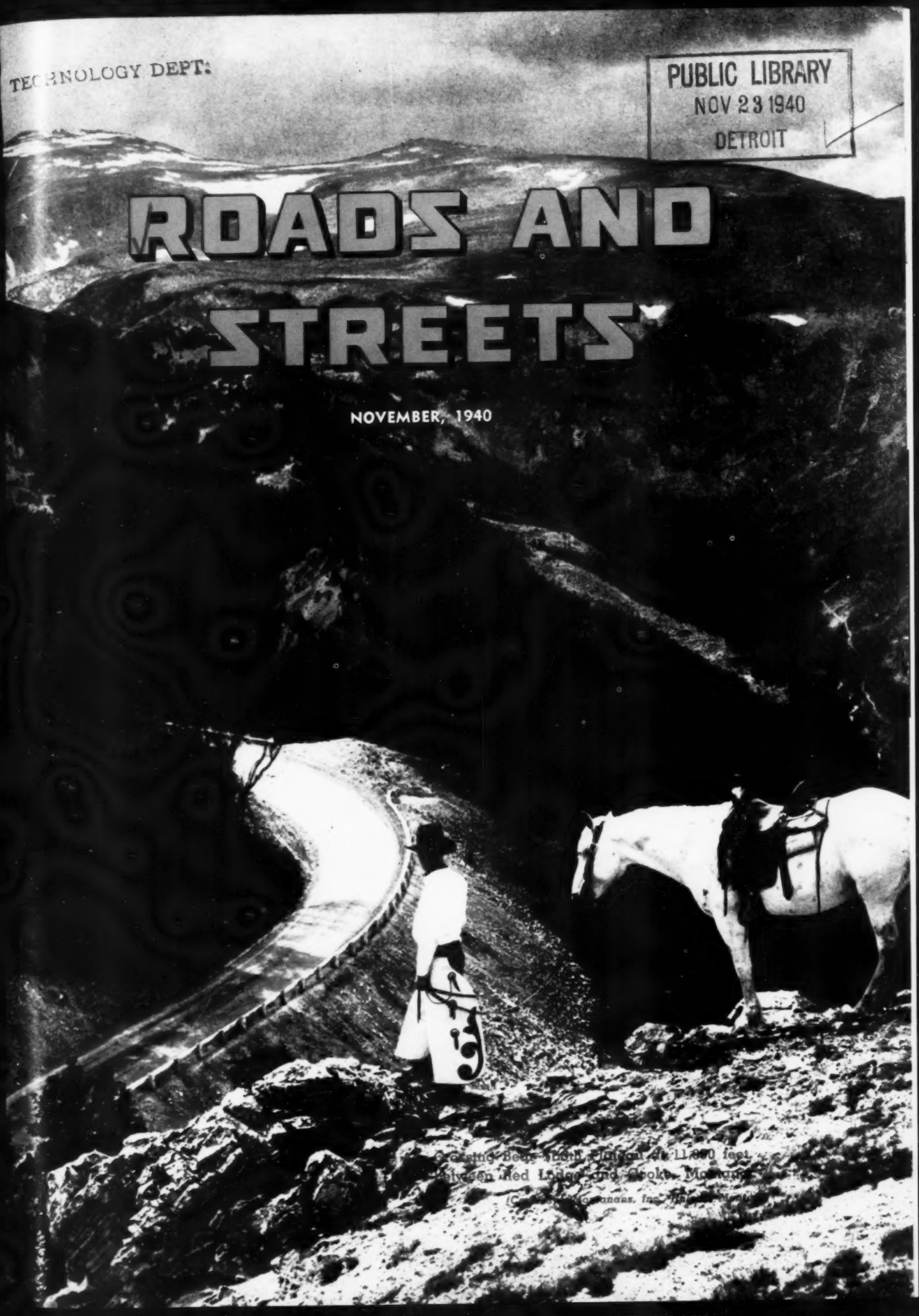

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All photos by New Jersey State Highway Department

FIG. 1 Smooth White Curb—Dry and Wet

Fig. 1. Here is a strip of ordinary smooth white concrete curb under car headlights at night. It's only slightly more visible than the road. And when water (shown by arrow) covers the curb and road, there's a complete blackout. The curb disappears.

Here's the reason: Smooth curb and road reflect most headlight rays forward, away from the driver; visibility is poor. On a rainy night, water fills the slight irregularities of smooth curb and pavement, causes them to act even more like a mirror, and to reflect even more headlight rays forward, away from the driver; visibility is nil (shown by arrow). Road and curb are almost completely obscured.

FIG. 2 White Reflecting Curb on rainy night

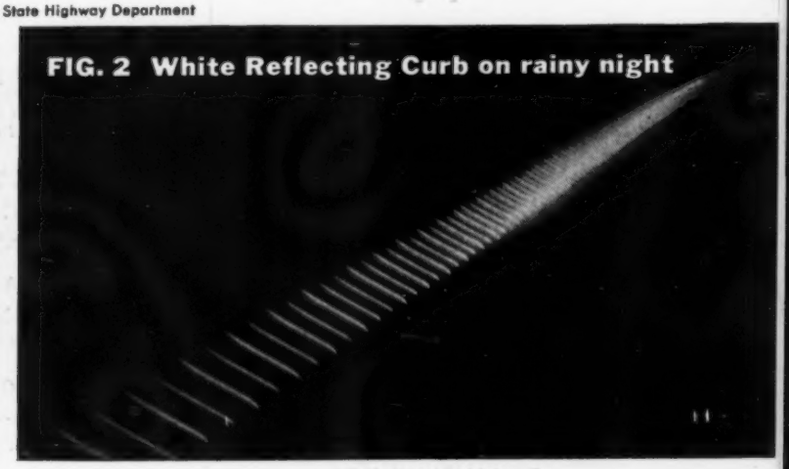

Fig. 2. White Reflecting Curb makes a gleaming ribbon of light extending far in front of the car. Even under unfavorable conditions—on a rainy night, as here—the curb itself seems to be lighted. But actually this is simply due to the light reflected from the driver's headlights—no other illumination.

The reason is simple: Smooth curb wastes the headlight rays, reflects them forward, away from the driver; visibility is poor. But the specially designed saw-toothed faces of White Reflecting Curb conserve the headlight rays, catch and reflect them back to the driver; visibility is high. And on wet nights the film of water on the reflecting faces intensifies the reflection—illumination is even brighter—visibility is even higher—night driving is safer.

FIG. 3

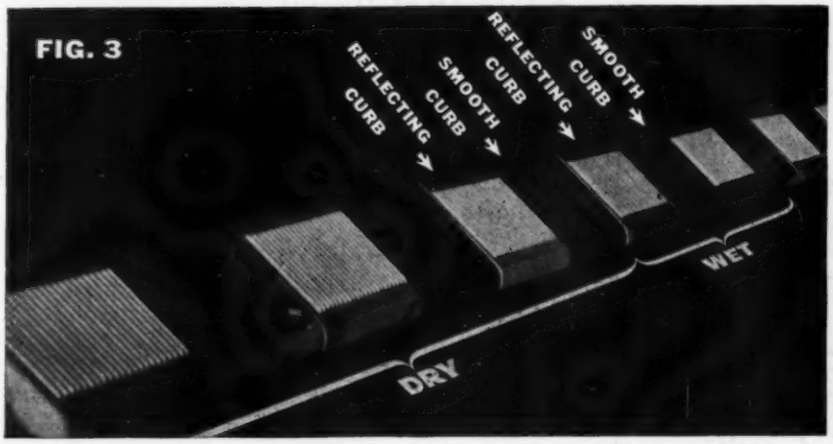

Fig. 3. A New Jersey State Highway Test: Alternate sections of smooth white curb and reflecting white curb under dry and wet conditions as seen by night drivers, under car headlights only, with no other illumination. All sections, the smooth ones which appear dark, as well as the reflecting sections which appear white, are made of identical white materials.

White Reflecting Curb made with Atlas White cement provides a curb that defines the road by day, is highly visible on dry nights, and even more visible on wet nights.

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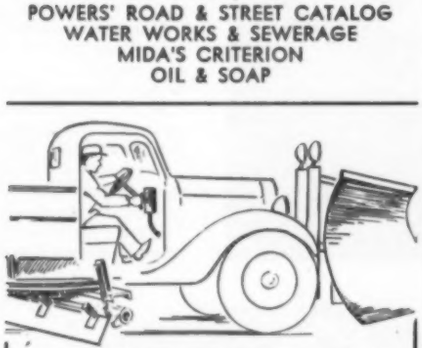

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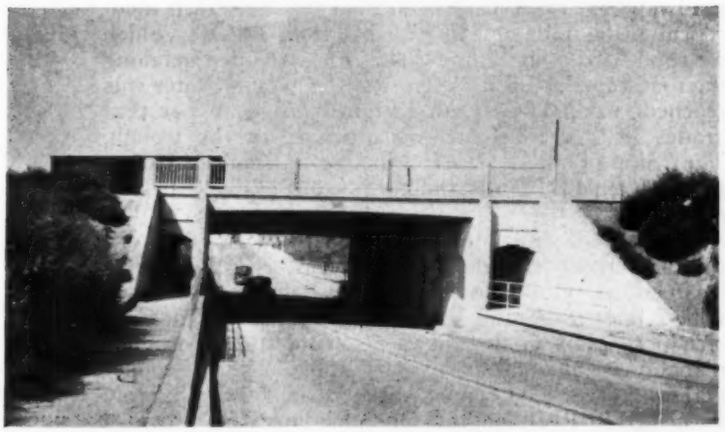
THE WOLF POINT UNDERPASS

Montana Structure Sealed Against the Entrance Of Ground Water



By R. A. STEPHENSON

Bridge Construction Engineer, Montana Highway Department

THIS article deals with the design and construction of a highway underpass beneath the main line of the Great Northern Railway Company at Wolf Point, Montana. The outstanding feature of the structure is the method of sealing out ground water by means of a concrete subslab, details of which are described herein.

Underpass locations, wherein the ground water level is above the subway grade, are frequently encountered.

Excavating for Subway After Temporary Trestles Were in Place

This is particularly true in Montana due to the fact that highways and railroads, in serving centers of population, naturally follow irrigated valleys adjacent to the larger rivers. Where sufficient fall can be obtained, gravity drains afford an economical solution, however, natural conditions often make such a solution impracticable, with the result that automatic pumping systems are necessary.

In providing pumping systems for drainage, it has been the general practice to drain the material outside and below the structure. Drain tile, installed below the roadway slab and back of the abutments, carry the water into a sump pit from which it is pumped to the surface by means of an automatic, float-controlled pump. Such a system is generally satisfactory where the flow is moderate, however, maintenance and power costs become excessive when a heavy flow of ground water exists. Furthermore, there is always the possibility of failure of the pumping system with resulting flooding of the underpass. Still another difficulty frequently encountered lies in the tendency of such drainage systems to diminish the flow of springs and wells supplying water to ranchers in the vicinity.

In the case of the Wolf Point underpass, preliminary investigation revealed that an extensive layer of water-bearing sand and gravel existed at the proposed subway level. Beneath this stratum, a fine silt extended for an unknown depth. Sufficient fall for a gravity drain could not be obtained without carrying such drain a distance of one and one-half miles to the Missouri River, which would make the cost of installation prohibitive. Furthermore, ranchers living immediately outside the limits of the city, where the city water supply is unavailable, depend entirely for their water supply from wells extending into the water-bearing stratum.

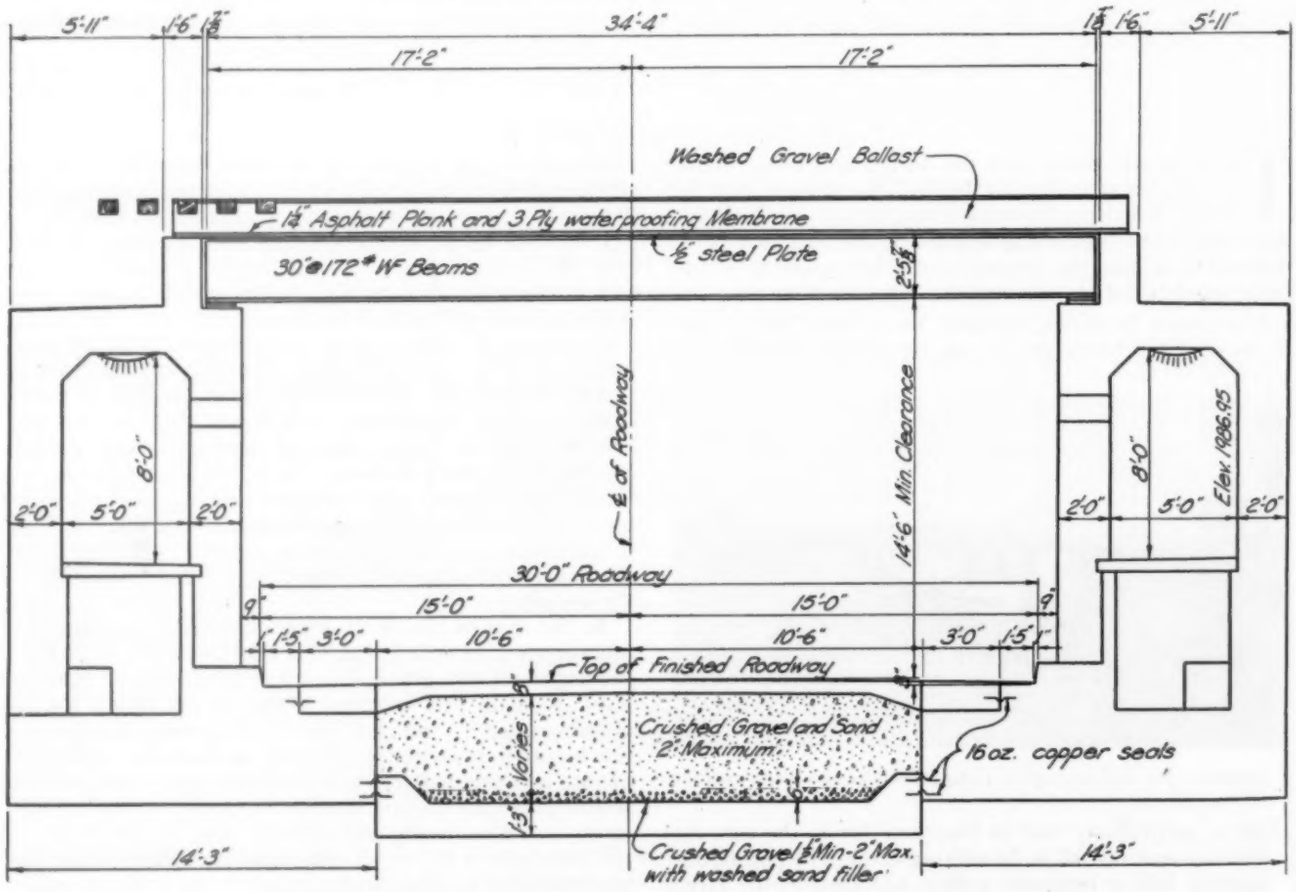
An overpass was considered, but was found to be out of the question due to the close proximity of the railroad to the main business street. Therefore, the most feasible plan was to use an underpass structure wherein the ground water is positively sealed out of the subway. Design features and considerations are described below.

Subslab Design and Construction

At first, the possibility was considered of designing the roadway slab to resist the full hydrostatic pressure for the determined depth of ground water. This plan was abandoned because of excessive cost. A much cheaper plan, and the one finally adopted, consisted of pouring a subslab, weighted down with crushed rock ballast. The roadway slab was placed direct upon the ballast. For details, see the accompanying typical cross-section. In this design, the combined weights of the subslab, ballast, and roadway slab were proportioned to resist the full theoretical hydrostatic uplift. The ballasted subslab, which we refer to as "The Stone Boat," was extended up along the roadway slab until the level of the ground water was reached. Approaches were designed on seven per cent grades with a 330-foot vertical curve in the trough. The "Stone Boat" is 330 feet in length. Depth of ballast ranges from 4 ft. 1 in. at the low point of roadway to 3 ft. at the ends.

Expansion joints in the subslab were spaced at approximately 40-ft. centers. These joints, as well as joints between the subslab and abutment footings, were sealed with 2 lines of continuous copper seals as shown. Construction joints in the abutments were sealed in a like manner. At joints in the roadway slab, one line of copper seal was used. The copper sheets, 8 in. in width, were furnished in 10-ft. lengths. One-inch laps were provided for field soldering. To facilitate this soldering, the ends were tinned in the shop for a distance of 1¼ in. on both sides so that abutting pieces could pass either under or

Driving Foundation Piling for Permanent Structure



Typical Cross Section of Wolf Point Underpass

over the next piece. The rounded V-groove, and the bending over of one flange, were made in the shop. The other flange was left upstanding in order to fit flush against the form while pouring the concrete against one side. Upon removal of the form and prior to pouring the adjacent section, the upstanding flange was bent over into proper position by means of a special flanging tool. In the expansion joints, premolded expansion material was used over and under the V-groove to prevent concrete from entering the groove during the pouring operation.

Grading of the sand and crushed gravel ballast was designed to produce maximum density, and corresponding maximum weight, in order to keep the depth to a minimum. The materials were proportioned by weight and blended prior to placing. Due to limited space in which to work, final distribution of the ballast was largely a hand-operation. The material was placed in 8-in. layers and thoroughly compacted by rolling.

Placing Sub-Slab

In general, it was possible to pour the subslab directly upon the soil. In some areas, however, "mud boils" developed which required sealing. This was accomplished by excavating below the proposed subslab grade, and pouring a concrete seal over the soft areas. After the seal had developed sufficient strength, pumping was resumed and the subslab laid.

Pumping System

To take care of surface water entering the underpass, and any seepage that might occur, an automatic pumping system was installed. Any water entering the space between the subslab and roadway slab drains into a sump from which it is removed by an automatic, float-controlled, electrically operated pump.

General Design of Structure

The underpass structure was designed by the Great Northern Railway Company for Cooper's E-70 loading. Tracks were rearranged so that in the final layout, only three tracks pass over the structure. The main line and passing tracks are ballasted. The ballast is carried in a trough section of one-half-inch steel plates resting directly upon the girders. The ballast plates are lined with 3-ply membrane waterproofing and 1¼-in. asphalt plank.

Finishing Concrete. Note Batching Bins in Background

Girders for each track are composed of six 30-in. wide flange beams. The rails for the industry track are carried directly upon girders. Depths of girders were chosen to provide as much head-room as possible.

Placing Girders for Superstructure

The underpass provides a 30-ft. clear width of roadway between curbs, with a 5-ft. pedestrian sidewalk on each side. The minimum vertical clearance above the roadway is 14½ ft. Each abutment is supported on 139 treated timber piles 40 ft. in length.

Construction Methods

During construction, railroad traffic was carried on temporary pile trestles. Piles were driven down through the railroad embankment to an adequate depth below the proposed subway grade. Caps and stringers were placed, and excavation for the subway was made. All of this work was done under railroad traffic by railroad forces who also placed the girders for the superstructure.

Contract Prices

The underpass structure and approaches were completed at a cost of $129,300. Quantities and unit prices were as follows:

201,106	lb.	Structural Steel	@ $	0.075
149,448	lb.	Reinforcing Steel	@	0.0525
1,564.5	cu. yd.	Class "A" Concrete	@	26.00
51.5	cu. yd.	Class "D" Concrete	@	35.00
1,066.6	sq. ft.	1¼" Asphalt Plank	@	0.75
10,581	lin. ft.	Treated Timber Piling	@	1.15
686	cu. yd.	Structure Excavation	@	5.00
Lump Sum,		Pumping and Drainage System	@	2,388.00
Lump Sum,		Lighting System	@	750.00
Lump Sum,		Maintaining Traffic	@	950.00
1,062	cu. yd.	Crushed Ballast Fill	@	2.50
		Railroad Force Account for Constructing temporary trestles, etc.		6,894.00
18,449	cu. yd.	Unclassified Roadway Excavation	@	0.21
2,874.6	sq. yd.	6" Portland Cement Pavement	@	3.00
328.1	sq. yd.	8" Portland Cement Pavement	@	3.50
853.2	sq. yd.	Concrete Sidewalks	@	2.50
725.6	lin. ft.	Concrete Curbs	@	1.00
788	tons	Crushed Gravel Subbase	@	0.75

The entire project, which in addition to the above, included a bypass and connecting roads, represented a final completed cost of $197,000. Nolan Bros., Inc., of Minneapolis, Minnesota, was the general contractor. Structural steel was fabricated by the American Bridge Company. Paper, Calmenson and Company furnished the reinforcing steel. Treated timber piling was supplied by the National Pole and Treating Company. Copper seals were fabricated by the Alder Steel Products Company of Minneapolis, Minnesota.

Concrete aggregates, obtained locally, were proportioned by weight for theoretical mixes designed by the materials laboratory. Universal Atlas Portland cement was used. The average 28-day compressive strength of 59—6 in. x 12 in. cylinder specimens was 4,220 lbs. per square inch.

Supervision and Financing

The grade separation project was entirely financed with Federal Aid Grade Crossing funds. Contract was awarded and supervised by the Montana Highway Department: D. A. McKinnon, State Highway Engineer; R. A. Stephenson, Bridge Construction Engineer; B. J. Ornburn, Bridge Design Engineer; J. H. Morrison, Chief Bridge Designer; G. J. Johnson, Materials Engineer; M. C. Lockey, Division Engineer.

Direct field supervision was handled by Harold Tilzey, Project Engineer, and L. B. Crosswhite, Bridge Inspector. Iver Klevin was construction superintendent for Nolas Bros., Inc.

▼

At the recent annual meeting of the American Association for Testing Materials on the recommendation of Committee D-4 on Road and Paving Materials, two new specifications were approved covering material for stabilized base course and stabilized surface course. These specifications cover the quality and size of sand-clay mixtures, gravel, stone or slag screenings, sand, crusher-run coarse aggregate consisting of gravel crushed stone, or slag combined with soil mortar.

DEATH OF EDWARD J. HARDING

Photo by Brooks, Washington, D. C.

EDWARD JOSEPH HARDING, Managing Director of the Associated General Contractors of America, died suddenly on October 5th. He was one of the most outstanding and widely known men in the construction industry, and had been Managing Director of the Associated General Contractors since 1930. In addition to his regular duties at the time of his death Mr. Harding was serving as a member of the Construction Advisory Committee to the Army and Navy Munitions Board assisting in the defense construction program, and was a member of the Federal Advisory Council for Employment Security.

Mr. Harding had been with the Associated General Contractors of America for 21 years. After its formation in 1919 he became field secretary, in 1926 membership manager, and in 1929, assistant general manager. He traveled extensively, and his acquaintance with general contractors and their problems was unequalled. His first contact with the construction industry was in 1906 in connection with the condemnation of land for the Hudson Tunnels. He worked on the tunnels and the Hudson Terminal Building in New York City. From 1917 to 1921 he was manager for the James Stewart Company, general contractors, of New York City. Some of the construction projects under his management were Camp Pike, Little Rock, Arkansas; Camp Bragg, Fayetteville, North Carolina; Coast Air Station, Long Island; Camp Barges, Baldwinville, New York; naval base and arsenal, Norfolk, Virginia; and two projects at St. Nazaire, Vincennes, France.

Mr. Harding was born in Plainfield, N. J., June 13, 1889, the son of Edward J. and Julia A. (Kerwin) Harding. On November 10, 1913, he married the former Marie Ruth McCarty of Plainfield. They have a son, Edward J. Harding, Jr., an ensign in the Supply Corps of the U. S. Navy, and a daughter, Miss Ruth Anais Harding. Other survivors are his mother, two sisters, Misses Katherine, and Grace Harding, and a brother, Louis R. Harding.

▼

A NEW ONE FOR ROAD BUILDERS AND SHOVEL MFRS.

Nothing new under the sun? Well, perhaps, but certainly some surprising combinations. The following from the Tulsa Tribune for Oct. 15 describes one.

"Oil production without a well was declared possible in the grass roots field of Pecos county at a hearing before the Texas railroad commission today.

"R. C. Webster of Monahans, owner of the field, said he intends to try shoveling out the oil.

"The producing oil sand is only 60 feet below the surface and yields a viscous, 13-gravity crude that is usable as road oil.

"Webster asked authority to take out the oil by any means found practical and particularly to be allowed to deviate from a statewide rule that requires oil wells to be 933 feet apart. His request was taken under advisement."

SUB-GRADE TREATMENT BY MUD-JACKING AND FILLING

How Illinois Corrects "Pumping" Joints and Sunken Slabs

PART ONE

By PAUL J. KUNZER

Junior Highway Engineer,
Illinois State Highway Department

In this article the author refers first to the phenomenon known as "pumping" at pavement joints, its causes, and effects. He then describes the methods and equipment used by the Illinois State Highway Department to stop pumping action and correct damage done. He also calls attention to the fact that an adequate rock subbase seems to be a complete preventive for the trouble. The account is written in great detail and is recommended to all readers who have problems of pumping joints or sunken slabs. Because of its length we have divided it into two parts, the second of which will appear in our December issue.—EDITOR.

The Author

HIGHWAY engineers are now confronted with the serious problem of prolonging the life of their heavily traveled pavements. The rapid increase in volume, speed and size (weight) of modern traffic is hastening the process of destruction of main highway systems. This trend is not localized, although investigation has shown that heavier traveled roads reach their stage of deterioration long before the lesser used roads show any signs of failing. The major portion of taxpayers' money being spent on these main highway systems puts a proportionate burden of maintenance on the engineers in the interest of public safety and convenience.

Early in 1939 the Division of Highways of the State of Illinois began an investigation on Illinois Route 48, a heavy truck route between Taylorville and Decatur; and later in the summer the equipment was transferred to the Skokie Highway (U. S. Route 41), a super-highway in Lake County which is probably the most heavily traveled road in the mid-west. The road consists of two divided 20-ft. concrete pavements with curb and gutter on the inside lane. The load-bearing joints are 30 ft. apart—two contractions joints to one expansion joint. "Pumping" had developed at many of these, and close inspection showed that heavy vehicular traffic was the chief factor.

"Pumping"—Its Causes and Effects

The natural set of concrete with anchored joints causes slight rises at the joints, and under some conditions constant heavy traffic eventually jolts the slabs loose, producing vibrations in the pavement and subgrade. Due to the pounding and impact received at the joints, the farther thirty foot slab, in terms of the flow of traffic, is jarred loose first. The movement in the slabs forms openings at the joints and edges, and soon creates a transverse crack. Surface water then enters the subgrade through these openings. The water accumulation between slab and subgrade causes all the damage, but surface water is only a part of the accumulation. The slab movement apparently induces a capillary action on the subgrade, for "pumping" has been detected on good subsoils as well as on clays and silts. Larger amounts of water are trapped under the pavement in the spring when frost is leaving the ground than at any other time. With the addition of the spring rains there is consequently excessive "pumping" and considerable settlement of pavement slabs prevalent throughout the country.

As the process continues, more and more movement occurs on the far slab until the trucks begin to force out the water accumulated under it. However, with the beating to which the subgrade has been subjected, some of the soil has been agitated with the water, and thus some of the subgrade soil is forced out from under the pavement. Once this stage is reached its progress becomes more rapid and the consequences to our pavements are obvious.

Fig. 1.—An Expansion Joint at Which Pumping Is Well Started. Arrow Indicates Direction of Traffic

This condition is at its worst immediately following a rain. Heavily loaded trucks have been followed, and at some joints which are far along in the process (having caused the far slab to settle about 3/8 in.) can be seen pumping water and mud two feet into the air as they pound over these joints. That explains the term "pumping," or "pumping action." Nevertheless, most of the water and mud is forced out at the edge of the pavement. It is only after a rain that pumping is noticeable on the pavement. Progressively a larger and larger opening is formed at the edge allowing more surface water to enter, and following with more and more of the subgrade being forced out.

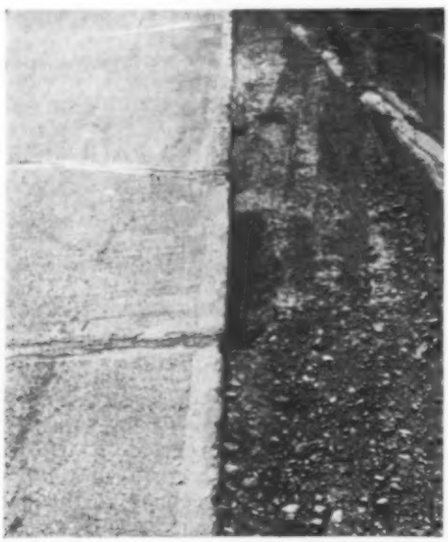


Fig. 2.—Same Joint as in Fig. 1 Eight Months Later. Notice the Transverse Crack and Pumping Effect Just Beyond It

Fig. 1 shows an expansion joint having a good start on its process in pumping. The thirty foot slab had no transverse crack when the picture was taken. In all cases the opening is formed on the far side of the joint. The same holds true for cracks although their progress is somewhat slower. Fig. 2 shows the same joint eight months later. Notice how the process has advanced. A transverse crack has resulted and it, too, is already showing signs of pumping.

Passenger automobiles, regardless of speed, cause no pumping at the joints. Trucks do, and the heavier their weight, the more material they pump out. Likewise, truck speed materially affects the pumping. Speed increases the impact at the joints, and therefore greatly increases the amount of material pumped out from under the pavement.

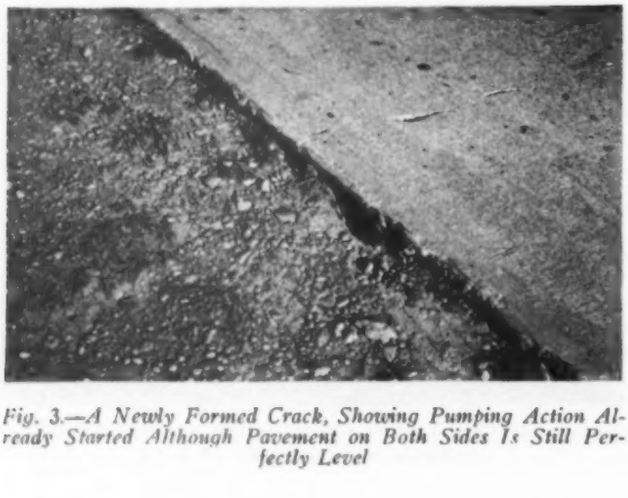


Fig. 3.—A Newly Formed Crack, Showing Pumping Action Already Started Although Pavement on Both Sides Is Still Perfectly Level

Another extremely hazardous condition resulting from "pumping action" came to light this past winter. In the season of freezing and thawing when considerable surface water is apt to find its way under the slab, the trucks pump it back onto the surface. Toward evening it freezes and forms very dangerous ridges which give traffic a bad jolt. The snow plows were unable to cut the ice off, and its removal was a costly undertaking. Fig. 4 shows one of these ridges. It can be seen that the ice (all our investigation bears out this fact) forms on the outside or heavily used traffic lane. Very little pumping has as yet been discovered on the inside lane. Some of these joints had as much as a 3-in. thickness of ice on their surface. Luckily no accidents were reported due to this condition, but it proved conclusively that a solution had to be devised.

Our assumption is that cavities have formed along the joints, cracks, and center steel. That is plainly evident since the subgrade material is forced out. How large and how many others exist under the pavement we do not know, but there is no doubt that even the smallest cavity would eventually cause a lot of harm. The voids under the slab, regardless of how small, had to be filled and sealed to prevent further damage to the pavement, and if no damage had started, prevent its occurrence or at least lessen its effects.

Fig. 4.—Ice Ridge Formed by Water "Pumped" from an Expansion Joint

Indications of a possible capillary action were discovered when we drilled some holes in the pavement at various places during a dry spell. When we forced compressed air into the holes, water was forced out along the joints, cracks, center steel crack and edges of the pavement. The ditches were in good shape at least 18 in. below the top of the slab and were completely dry. Some sum-

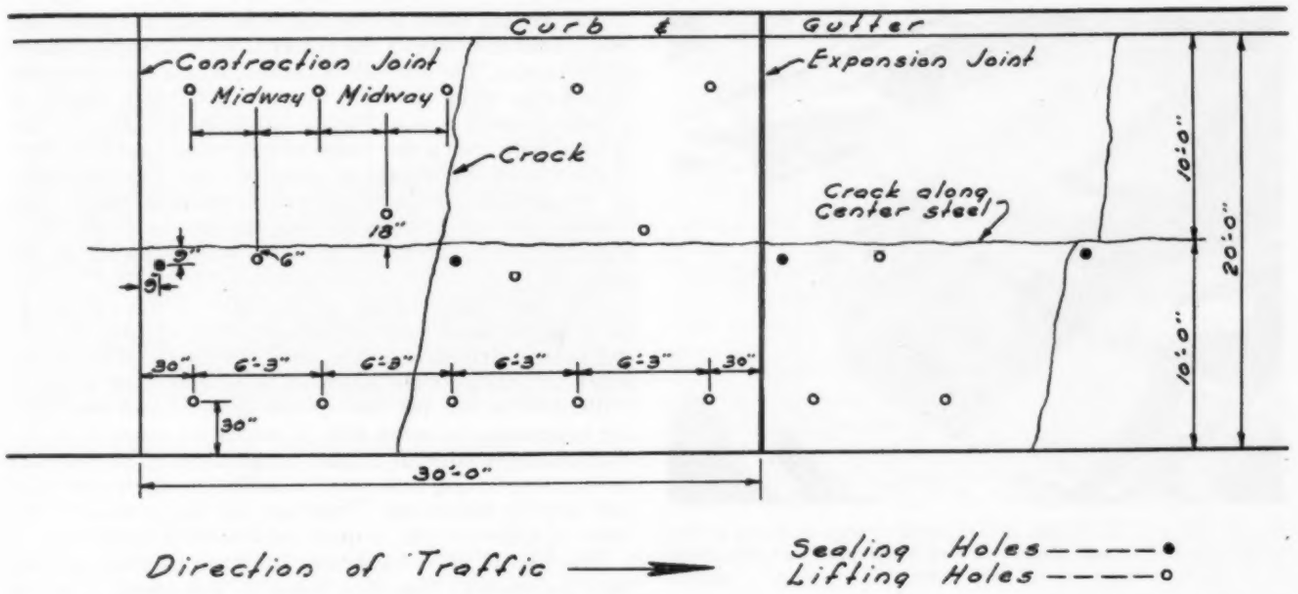


Fig. 5.—Plan Showing Location of Sealing and Lifting Holes with Reference to Joint and Cracks. The Curb and Gutter Adjoin the Landscaped Center Strip Which Divides the Highway

mits showed the same condition, and cuts and fills did likewise.

Gravel Subgrade as a Preventive

French drains have been found unsatisfactory. They will not solve the pumping problem and their cost is excessive. We tried some at the joints and although they worked and drained the water for a short time, they are now sealed up with mud after a period of three months.

Perhaps the answer to the problem is the replacement of subgrade material with gravel. No pumping has yet been discovered under grade separations or underpasses where subgrade replacement has been provided. It so happens that a 600-ft. section on this road has also been provided with gravel replacement 12 in. thick. This section is still in good condition, shows no pumping and when we attempted to blow water as we had done on other sections we were unsuccessful. The only joints showing any signs of water under the slab were at the extremities of the replacement section, and these had very little in comparison to the general condition. Also, the pavement is still level, and even the far slabs at the joints have not shown any settlement.

The General Method of Treatment

At the time of our investigation a similar "pumping" condition existed at various places on Route 42A, the next road paralleling Skokie Highway. It is a two-lane road with no joints but carrying considerable truck traffic. Sections of this road that were badly cracked and pumping excessively were chosen for treatment. The small mud-jack, compressor and truck with a foreman and crew of eight men were used. Different mixes and ideas were tried on the various sections and our present procedure developed as a result of this experiment. Five sections of 750-ft. lengths were treated. Two of these were in such a condition as to necessitate extensive replacement. Today all five are still in use and in a good safe condition. A season of freezing and thawing did not affect them. Just recently it was observed that a few of the cracks are commencing to show signs of pumping again. These will be re-sealed this season, and the life of these sections will be prolonged for another year.

The method of treatment is as follows: Sunken and settled sections of the slab are first lifted back into place or as near into place as possible. Any jar or impact must be eliminated, and this is accomplished by the proper application of the primary function of the mud-jack. All existing slab movement is thereby reduced to a minimum. This raising and at the same time the tightening of the loose slabs (invariably the sunken and badly broken sections have excessive movement) eliminates the worst condition resulting from the "pumping." The second step is to fill up or seal all the voids that have formed under the slab. Since our investigation indicated that the greatest number and the larger size of voids occur along the joints, cracks (probably formed as a result of the voids) and center steel, we force a mud-mixture with the aid of compressed air, through a hole drilled as near as possible to the joint or crack and center steel, so that it will flow in all four directions under the slab along these voids, thereby filling and sealing them. Our experience indicates that our method accomplishes these two objectives very efficiently and economically, and we thus do away

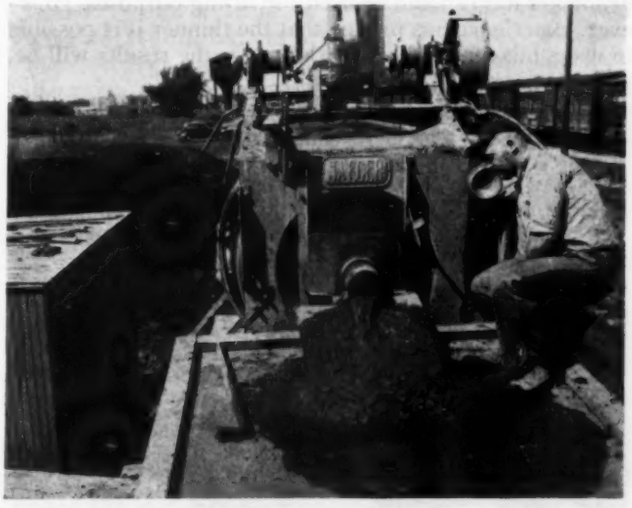


Fig. 6.—The First Mixer Discharging Onto Punched Plate. Only Top Soil and Clay Are Mixed Here, the Other Ingredients Being Added at Second Mixer

Fig. 7.—Shear Gate Valve at Bottom of Slurry Box and a Part of the Skip of Second Mixer. Cement and Lime Dust Are Added at This Point

with the source of the damage; not permanently perhaps, but as near to that as is possible.

Drilling and Location of Holes

All drilling is done with a 105-cu. ft. air compressor. Three men are required, two drillers and one flagman. Their rate keeps them slightly in advance of the mudjack. The chief operator lays out the holes in advance and then assists in the drilling. A length of 150 ft. is covered in one setup. The air hammers are two small S-35's using 18x⅞-in. hexagonal shanks with 1⅜-in. six-point bits. Not only are the small light air hammers convenient for the operators, but since they do not strike too heavy a blow there is no danger of breaking a chunk off the lower side of the slab as the drill goes through. The life of a bit averages 30 holes, and it is then discarded.

In our work we define the holes as "sealing holes" and "lifting holes," although they are of the same size. The sealing holes are those used only to fill, or seal, the cavities under the slab. They are never used in raising the pavement. Lifting holes are those used only to raise or lift the slab back into place, and are so located as to give maximum lift with a minimum of effort and strain. To achieve this where slabs are broken or sunken, a stiffer or thicker mud should be used for lifting purposes. However, experience has proven that the thinner it is possible to use a mixture for lifting the better the results will be.

Fig. 8.—Skip Charging Second Mixer from Top of the Extended Track

The sealing holes are drilled 9 in. from the joint and 9 in. to the low side of the center steel. The same is done at the cracks. The low side is chosen in case the pavement should rise when the mud mixture is being pumped. A definite pattern is used for the lifting holes (Fig. 5) but in very few cases is the complete pattern per joint needed. If further lifting should be required later, the remainder of the pattern can be completed. Trials and results with various types of layouts proved this one to be the most effective, least expensive and the least harmful to the slab.

The three lifting holes to the right of the expansion joint are the most common in our work to date. A sealing hole is drilled at every joint and crack. The lifting holes are drilled only when there is a definite drop or settlement at the far side of the joint. Naturally there are exceptions to every rule. If excessive pumping is indicated at the edge of a joint (regardless of settlement) at least one lifting hole may be drilled to tighten the slab and stop its movement. There are also badly broken sections at culverts that require additional lifting holes.

The 1⅜-in. holes have been found to be adequate and least expensive. Traveling even at a moderate rate of speed they are unnoticeable to drivers, and when tires ride directly over a line of them no jar or noise results. Larger holes would jar a car and cause a rumble indicative of a flat tire which is very inconvenient to the traveling public.

Mix

The mix we are using at the present time gives very favorable results and appears to be the best we have tried. The mix by volume, is as follows:

Cement	8%
Lime Dust	6%
SC-2 oil	13%
Top soil	25½%
Clay	6½%
Water	41%

The cement is necessary to give the mixture a set, stability and compactness. Of more importance is that it reduces shrinkage and offers good firm support for the slab. Lime dust is low in cost, has the same advantages as cement although to a lesser degree, and aids primarily in holding the oil in the mixture. Its use reduces the amount of cement required. We require a faster set due to the fact that one lane of the road we are working on is kept open to traffic. The oil keeps the mixture plastic, tends to waterproof the subgrade, and waterproofs the mixture after the water has evaporated. Several kinds of oil were tried, but the SC-2 gives the best results in producing a uniform, thorough mix and the plasticity desired. Plasticity is required to prevent the mixture from cracking and breaking up.

Black top soil does not contain much sand, is comparatively low in shrinkage, has a natural stability, and with the addition of a little clay, gives a very fine, smooth molecular mix when broken up. A small amount of fine sand would be desirable to decrease shrinkage and add to the stability, but it settles out too rapidly and produces a harsh mix. Harshness is objectionable since it makes the mixture difficult to pump, causes it to flow unevenly into the voids, and produces considerable wear on machinery and equipment. Clay has proven to be the greatest asset to our mixture and has been our most recent successful discovery. Heretofore it had been shunned because it is well known that it has a high factor of shrinkage. However, with all the ingredients added and the small percentage of clay used, its effect is changed completely. It gives a body and weight to the mixture. Its particles are so fine that it keeps the entire mix in a col-

Fig. 9.—General View of Mixing Plant. First Mixer (10-S Concrete) at Right, Slurry Box in Foreground, Second Mixer (10-cu. ft. Bituminous) Above and Behind Slurry Box, Storage Box at Left

lodial suspension, which is essential after the mix is pumped under the pavement. The clay prevents the sand particles present from settling too rapidly, and forms a smooth flowing paste or lubricant for the mix. To obtain a similar result we had used more lime dust, but that gave a light fluffy mixture, thus not offering enough support for the slab. The addition of clay reduced the amount of lime dust 50 per cent.

Various important features of the ingredients of our mix have been explained, but it must be remembered that very many things are to be considered in designing such a mix. Our problem was to eliminate harshness and shrinkage, and to find a mixture that gives a smooth even flow, remembering it must be such that it can enter a very minute cavity and give a good permanent support to the slab.

Since our settlements are reasonably small we can use the same consistency for both sealing and lifting. Our mixture has the consistency of a thin mortar. This may seem too thin but again it must be remembered that we are sealing voids under a pavement, and to do so the material must flow through some extremely small openings without raising the slab and defeating its purpose.

The Mixing Plant and Its Operation

Our mixing plant is operated by six men. Two are required to run the two mixers and two to charge them.

Fig. 10.—Second Mixer Discharging Into Storage Box

One man is required to keep the screen clean and open, help in the cleaning of the mud mixer when it becomes clogged and also the slurry tank. One man with truck is needed to haul our supply of oil, dust and cement to the plant site. This man also has charge of the distributor.

The top soil is obtained from the shoulder and ditch of a nearby highway. Clay is gotten from the adjacent town where they were laying a water main. We stockpiled enough of both to last the entire season. Our first mixer is a rebuilt 10-S concrete mixer mounted on a truck and having an extended track skip. It mixes 8 cu. ft. of soil including clay, and 4 cu. ft. of water per batch. The drum had to be rebuilt and sealed to prevent the splashing out of the slurry. A splash plate was added on the skip side, the throw-over blades cut down, and the mixing blades extended. To break up the clay and lumps we found it necessary to put about 70 large 3-in. size gravel stones into the drum. A different type of discharge chute had to be designed; and we solved the problem by using a 3-ft. length of 6-in. pipe. Fig. 6 shows the discharge side of the drum sealed up with the pipe in the discharge position. The accumulation shown on the screen is the loss from a batch, amounting to about 3 per cent, and consisting of lumps, sod, stones, etc. The section of the discharge pipe within the drum is provided

Fig. 11.—Loading a Batch Truck. 850-Gallon Oil Tank Trailer at Right

with a drip ring and widened to extend under the mixing blades. Two-thirds of the perimeter of this section was cut off, to which the widening was added to provide a discharge opening. This opening is grated or screened by twelve 1½ in. x 12 in. x ¼ in. steel spacers set edgewise on 1½-in. centers around a steel shaft to prevent the discharge of large lumps and the gravel shot. In the discharge position these spacers lay rigidly on the chute and hang freely and loosely in the close position. To clean out the clay and lumps which may clog the openings, the operator merely reaches into the drum and lifts the spacers up one at a time to wipe off the lumps between them. This occurs only occasionally, since the gravel serves a dual purpose in that as it falls on the chute in the closed position the loosely hanging spacers are jarred around to the extent of cleaning themselves.

The important features of the mud, or slurry, mix are to have the water in the mixer first and then give sufficient mixing time per batch. At least 5 minutes is required to break up the clay, get it thoroughly mixed with the soil and get the particles into a colloidal suspension. This gives a rich, creamy mixture of mud. More mixing time is used whenever possible to break the particles up finer and get the advantage of a better suspension.

The slurry is discharged upon a standard punched ¼-in. metal screen completely covering the slurry box.

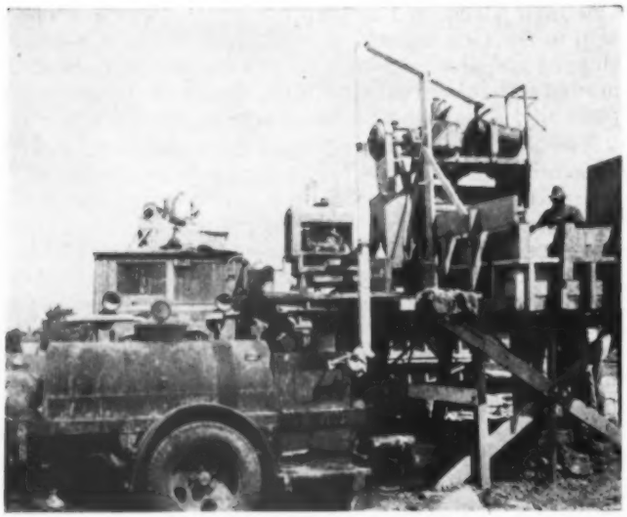


Fig. 12.—Distributor Drawing Oil from the Supply Tank and Pumping It Through Asbestos Covered Pipe to Oil Tank and Gauge on Top of Bituminous Mixer

The punching on the screen is staggered, alternate rows being on ¾-in. centers. The screen is 14 ft. by 6, and the punched area 12 ft. x 5. It has a good fall from the mixer, and the last 4 ft. of the screen is hinged, making it possible for a man to get into the slurry box to clean it and stir the slurry when necessary.

The slurry box has a capacity of 10 cu. yd. (12 ft. x 5 x 6) with the inside constructed as a hopper towards the center and side of the box, where a 6-in. shear gate valve is located. The valve and bottom of the box have been set into a concrete footing and floor. Fig. 7 shows the shear gate valve construction at the bottom of the box. To keep the slurry stirred up and in suspension, and prevent it from settling, it is agitated by a 2-in. centrifugal pump. This also aids in keeping our proportions accurate, since the slurry is kept at a fairly constant consistency. The pump sucks the mud from the bottom and pumps it back over the top preventing the particles from leaving the suspension, and further decreasing their size by cutting up the particles already in suspension. Fig. 9 shows the pump at ground level at the near end of the slurry box.

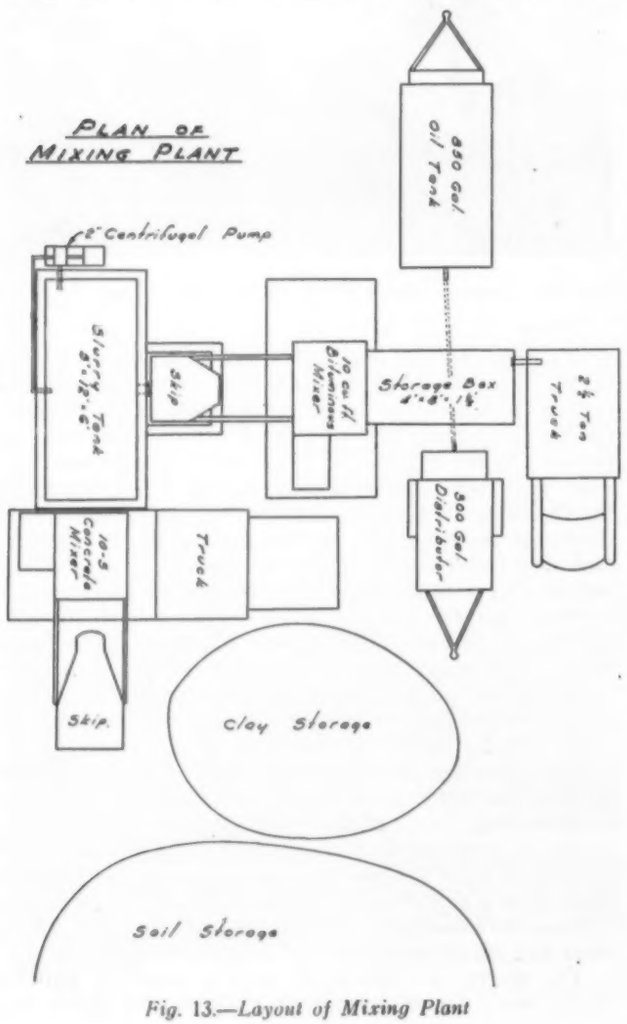


Fig. 13.—Layout of Mixing Plant

The second mixer, a 10-cu. ft. bituminous mixer with a figure-8 mixing blade, also has an extended track skip. From the bottom of the slurry box 6 cu. ft. of slurry is charged into the skip and one bag of cement and lime dust added. A concreted box had been provided for the skip below the valve. Fig. 7 shows the loaded skip. Fig. 8 shows the extended track provided with guides and the skip just coming to the dumping position. The mixer operator adds approximately 25 gal. of water and 13 gal. of SC-2 oil. Three minutes mixing time is sufficient for a thorough mix. This gives us a 12½ cu. ft. batch which is dumped into a smaller storage box holding two batches. These and a third batch held in the mixer constitute a load for our batch trucks. The final mixture is also dumped upon a small ¼-in. metal screen set in the storage box to take out any lumps that may have formed from the cement or lime dust. The discharge from the storage box consists of a 4-in. protruding pipe, with another homemade shear gate valve. Fig. 10 shows the mixer discharging and Fig. 11 shows the loading of a batch truck. We are using two small 2½-ton batch trucks for our hauling.

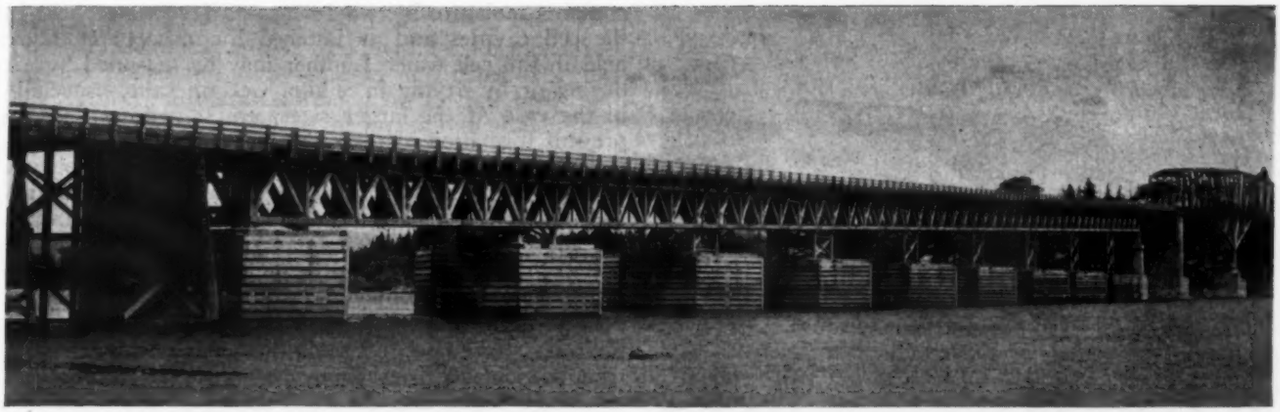
Oil is trucked to the plant site in two 850-gal. trailer tanks. A 300-gal. distributor draws the oil from the tank and pumps it up to a homemade oil tank and gauge of 15 gal. capacity located on top of the bituminous mixer. Figs. 10 and 12 show the oil calibrating device and tank at the upper right of the pictures. Fig. 12 is a close-up of the distributor and asbestos covered pipe to the calibrating device. The water tank is still used to measure our water, although it has been shifted over to make room for the oil tank. The oil in the trailer tanks must be heated to be drawn off, and the oil in the distributor is kept at 150 degrees to flow properly and not clog up the pipes and calibrating device. The heaters are started early by the watchman so that all is in readiness when the men come to work.

Water is obtained through 1,000 ft. of 2-in. pipe from the city main of Highland Park where the plant is located. A hose line for the operation of each mixer and another for cleaning purposes is attached. Considerable water is needed, and access to a city main greatly reduces the cost besides providing sufficient pressure for all needs. Fig. 13 shows the layout of the plant.

(To be concluded in December)

AMERICAN SOCIETY OF CIVIL ENGINEERS WILL STUDY PROTECTION OF CIVILIANS IN WAR

George T. Seabury, Secretary of the American Society of Civil Engineers announces, in behalf of Colonel John P. Hogan, President, that at a recent meeting the Board of Direction of the Society had resolved to appoint a committee to study the whole subject of protection of civilians in time of war.



Up-River Side of a Columbia River Bridge with Lumber Deck and Asphalt Wearing Mat Showing Nine 90 ft. Wood Truss Spans

WOOD AS A STRUCTURAL MATERIAL

A Review of Certain Qualities and Characteristics Which Contribute to Its Wide Range of Uses

PART ONE

By FRANK J. HANRAHAN

Structural Engineer,
National Lumber Manufacturers Association

The author here discusses the nature and behavior of wood under various conditions of air and moisture; its electrical, chemical and heat transmitting properties; the grading of lumber, with special reference to "stress grades;" methods of preventing decay and of preventing and overcoming attacks by termites; fire resistance and fire prevention; and modern methods of fastening in major construction. The adaptability and dependability of timber in structural service are clearly presented. The data on fire resistance will come as a distinct surprise to some readers. The second part of this article will appear in our December issue.—Editor

MODERN structural design in wood is quite different from the unscientific rule-of-thumb approach of a few decades ago. Intensive research by the U. S. Forest Products Laboratory and others has revealed the chemical, physical and mechanical properties of wood. Accurate methods of computing the effects on strength by natural characteristics of lumber have been devised and incorporated in practical lumber grading rules. Commercial stress grades of definitely known strength have been established. Improved seasoning processes, more accurate machinery, improved grades and other factors have brought about many improvements in the product itself. Research has outlined the limitations of wood destroying agencies and has evolved practical preventative and curative treatments and construction practices. It has developed more efficient and economical methods of fastening. In other words, the technical information and commercial grades of lumber which make possible accurate design in wood are available today.

As a profession charged with the responsibility of protecting life and property while determining ways of rendering the best service at the least cost, we engineers should not confuse facts with prejudices concerning the materials with which we work. Neither should we be ignorant of technical developments in our field. In these days of keen competition between materials it is often difficult to distinguish the scientific truths from the supposedly technical, but frequently optimistic, statements made by non-technical sales promotion agencies. It is the

Buffalo Creek Bridge, Lewisburg, Penna. This Bridge Consists of Two 91 ft. 6 in.—Spans of Wood Fastened with Timber Connectors. It Is Located on a Pennsylvania State Highway, and Is Designed for H-20 Loading

One of Two Similar Connector-Built Wood Trestle-Type Bridges 755 ft. in Length, Made Up of 29 ft. Panels with Maximum Height of 100 ft., 24 ft. Clear Roadway with 4 ft. Sidewalk Both Sides, Designed for H-20 Loading, and Located in Port Angeles, Washington

purpose of this article to point out some of the more important facts concerning one of our major structural materials; namely, wood, all of which can be verified by recourse to the technical findings of unbiased reliable agencies.

Nature of Wood

Wood is an extremely complex organic matter. It is composed essentially of cellulose in minute elongated cells, called fibers, firmly cemented together by lignin. The strength of wood depends largely on the thickness of the cell walls, and therefore its specific gravity is a good indication of its strength. Since the specific gravity of wood substance itself is about 1.5 regardless of species, and that for native commercial oven dry woods based on the volume at 12 per cent moisture content varies from about 0.31 to 0.73, it is evident that a considerable portion of the volume of a piece of wood is occupied by cell cavities and pores.

The cross section of a mature tree will show a fairly wide band of wood (inside the bark) called sap wood, surrounding a cylinder of heart wood, which is generally somewhat darker in color. The heart wood of living trees is composed of dead cells which were once living cells in the sap wood. There is no difference between sap wood and heart wood so far as strength is concerned and sound wood from dead trees is as strong as that from living trees. Heart wood is more durable under conditions conducive to decay, but sap wood absorbs preservatives better than heart wood and is preferred for treating purposes. When grown under the same silvicultural conditions, virgin growth and second growth trees of any given species have the same properties.

Seasoning

Seasoning of lumber is essentially the process of drying the moisture out of the wood. Many trees when living have moisture content well in excess of 100 per cent of the weight of the wood itself. Wood in a standing tree contains moisture in two forms: as free water held in the cell cavities and as imbibed hygroscopic moisture held in the cell walls. Lumber may be seasoned by air drying or by drying in a kiln. Certain salts, especially in the case of the larger sizes, are sometimes used to prevent formation of seasoning degrade during the drying process. In drying the cell walls retain their moisture until all the free water in the cells has been evaporated and then lose their moisture. The point at which the walls are about to lose moisture is known as the fiber saturation point, and is ordinarily somewhat in excess of 25 per cent moisture content by weight for most woods.

Differences in moisture content above the fiber saturation point have no effect upon the strength or volume of wood. As wood dries below the fiber saturation point shrinkage begins and the wood increases in strength.

Except for seasonal variations, wood in service will eventually reach a moisture content condition which is in moisture equilibrium with the humidity of the surrounding atmosphere. Under normal atmospheric conditions for most of the United States this point of equilibrium, in general, averages approximately half way between the fiber saturation point and the oven dry (zero moisture content) condition. Of course, in heated rooms where the relative humidity is low, this point may be at about a third, and in humid areas or where exposed to the elements about two-thirds of the moisture content at fiber saturation. However, since moisture content is expressed as a percentage of the dry fiber weight per unit volume of wood, all woods held under identical atmospheric conditions will either lose or take up moisture until they reach the same equilibrium moisture content.

Moisture and Shrinkage

With wood seasoned to, and installed at, approximately the moisture content which it will reach in service, only relatively minor changes in size, whether shrinking or swelling, will occur caused by the absorption or giving off of moisture due to atmospheric changes. Shrinkage parallel to the direction of the grain (length) is too small to be of practical importance in most uses of wood.

Experiments on the shrinkage of boards of a number of commercial softwoods show that for each 4 per cent change in moisture content there is a change in dimension of approximately 1 per cent across the grain; that is, at right angles to the fibers. The shrinkage in hardwoods averages slightly more.

In structural material of large cross section the change in size is less, due to its mass and the presence of knots. Large size members do not shrink as much proportionally because drying does not take place simultaneously in the inner and outer portions of such pieces. Since the inner part dries out more slowly than the other sections, the wood nearer the surface is prevented from shrinking normally. Later when the interior dries out, the extent of its shrinkage is reduced by the fact that the outer layers have become set and keep the inner portion from shrinking to the extent that it would normally. In softwood structural material 6 x 6 in. or larger in cross section, a shrinkage of approximately 1/64 in. per inch of width of face may be expected in drying from a green condition to ordinary conditions of use.

Softwood structural material 2 to 4 in. thick, while subject to a normal rate of shrinkage in seasoning, is usually partially or fully seasoned when marketed. Therefore, the average amount of shrinkage for seasoned material of these sizes that may take place in service ordinarily does not exceed 1/64 in. per inch of face. Hardwood structural materials may shrink slightly more than these amounts.

Moisture and Strength

The increase in strength of wood with loss of moisture below the fiber saturation point is due principally to actual strengthening and stiffening of the cell walls as they dry out, and somewhat to the increase in amount of wood substance per unit volume caused by shrinkage. Drying wood from the fiber saturation point to 5 per cent moisture content adds but a small percentage to its density, while in small pieces the end-crushing strength and bending strength may easily be doubled, and in some woods tripled, thus indicating that the drying of the cell walls is the more important factor. The increase in strength with seasoning is much greater in small clear specimens of wood than in large timbers. In the latter the increase in strength may be offset to a large extent if checking develops in seasoning.

The various strength properties are not equally affected by changes in moisture content. Whereas, some properties, such as crushing strength and bending strength, increase greatly with decrease in moisture; others, such as stiffness, change only moderately; and still others, such as shock resistance, may even show a slight decrease. This last effect is due to the fact that drier wood does not bend as far as green wood before failure, although it will sustain a greater load, and because shock resistance or toughness is dependent upon both strength and pliability.

The above data are given merely to indicate the relative effects of moisture content on the various properties in small clear specimens, and are not for use in design because growth characteristics tend to offset them in commercial sizes. The shrinkage that occurs in the drying of wood induces internal stresses. In time, equalization of differentials of moisture content combined with the action of wood as a plastic material relieves such stresses. This effect would tend to increase the resistance to external forces, but its effect is probably not great enough to be significant in most uses of wood.

Heat Transmission Through Wood

Heat transmission through wood varies with the density and moisture content, and to some extent with the wood structure. Thermal conductivity increases with moisture content, and the heavier woods have a higher conductivity than the lighter species.

At a moisture content of 12 per cent, the thermal conductivity of commercial softwoods and hardwoods varies from 0.65 to 1.22 B.t.u.'s per hour, per inch of thickness, per square foot, per degree F. of temperature difference between opposite faces. The average for all the woods tested, both softwoods and hardwoods being included, is 0.895 B.t.u.

Electrical Properties

Dry wood is an excellent insulator against the transmission of electricity. Its resistance increases as the moisture content decreases. The electrical resistance varies in different woods and with the direction of the grain, being greater across than with the grain. Temperature has a definite effect on electrical resistance, which is approximately doubled with each 22.5 degree F. drop.

Chemical Properties

In addition to the appearance, arrangement and physical composition of wood cells and structure, many woods contain complex chemicals which may be held in the cell cavities, or in other cases infiltrated in the cell walls. Among the well known chemical substances found in woods are gums, oils, resins, and tannins. To such chemicals is attributed in part the resistance of certain woods to decay and insect attack.

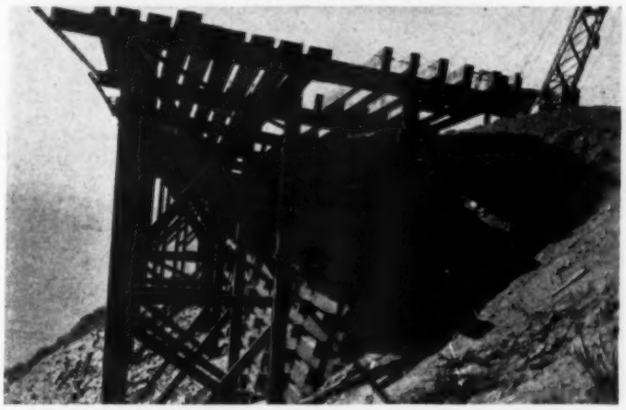
Wood substance is chemically inert, and can therefore be used in many locations where other materials will deteriorate from the presence of chemicals in the atmosphere or in the ground, i.e., chemical plants, railway round houses, tanks, etc.

So far as is known the lignin, cellulose, and other constituents which form the wood substance are not subject to chemical change or loss with time when wood is adequately protected from the elements and other destructive agencies, although the color of wood may be slightly changed by long continued exposure to air. Possibly this change of color results from oxidation of substances that are not parts of the wood substance.

Coal-tar creosote, and creosote mixtures used in the wood-preserving industry are practically inert to wood and have no chemical influence upon it that would affect its strength. The 2 to 5 per cent solution of zinc chloride commonly used in preservative treatment apparently have no important effect.

Mechanical Properties

The strength and stiffness of a piece of wood of a given species are dependent upon the combination of the physical and mechanical properties present in that wood. In different woods these combinations vary. The



Wood Cribbing and Trestle Designed by United States Engineers, and Located on Yerba Buena Island, San Francisco Bay

science of lumber strength determinations involves, therefore, an analysis of strength-influencing factors of all wood, the strength factors peculiar to each wood, and the evolution of simple rules for recognizing and evaluating these factors for the purpose of efficient manufacture, and the dependable use of wood for structural purposes. Of the structural materials whose properties are technically determinate, lumber is in the forefront as one of which the strength can be most definitely determined *by visual inspection.*

Since design data, formulas, and recommendations for lumber use are readily available from the lumber manufacturers associations, mechanical properties will not be discussed here.

Grades of Lumber

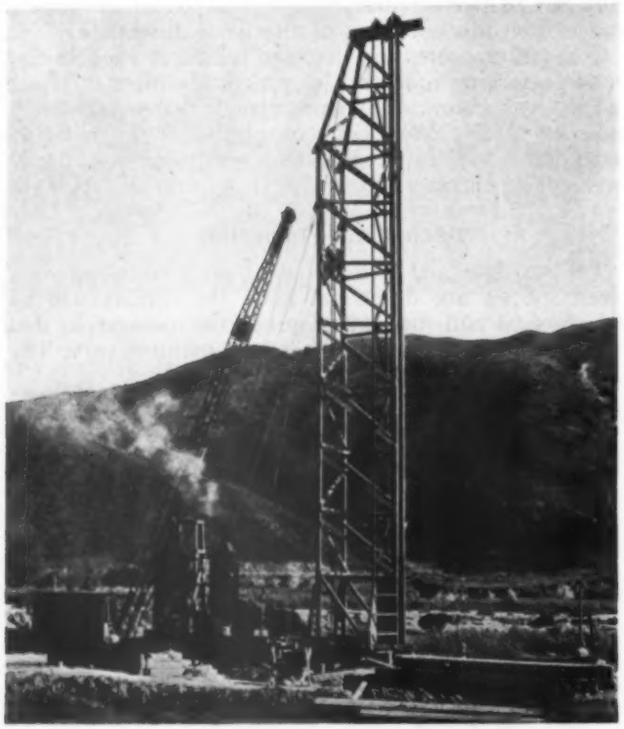
Standard lumber grades may be divided into three broad classifications; namely, yard lumber, shop and factory lumber and structural lumber—all based on use requirements:

Yard Lumber, which includes finish and common grades of lumber is graded largely on the basis of ap-

pearance and the use of the entire piece without further remanufacture. It is used for ordinary construction and general purpose uses, such as house framing, sheathing and paneling where exacting strength requirements are not necessary.

Shop and Factory Lumber, which provides the raw material for remanufacture into lumber products, is graded largely on the size of clear cuttings which may be obtained from the piece. It is used by sash, door, millwork, furniture and similar factories.

Structural Lumber, which includes the stress-grades, is graded according to factors which affect its strength as a beam or a column. This classification, which is of particular interest to structural designers, is used for railroad and highway bridges or trestles, and other engineered structures where consideration of accurate working stresses is necessary.



An 83 ft. Wood Pile Driving Rig Designed with Flush Type Shear Plates at all Joints, Which Permits Rapid and Frequent Assembly and Dismantling without Damage to the Members

The stress grades are classified according to their size and use into the following:

1. Beams and Stringers. Lumber of rectangular cross section, 5 or more inches thick and 8 or more inches wide, graded with respect to its strength when loaded on the narrow face.

2. Joists and Planks. Lumber of rectangular cross section, 2 inches to but not including 5 inches thick and 4 or more inches wide, graded with respect to its strength in bending when loaded either on the narrow face as joist or on the wide face as plank.

3. Posts and Timbers. Lumber of square or approximately-square cross section, 5 by 5 inches and larger, graded primarily for use as posts or columns carrying longitudinal load but adapted for miscellaneous uses in which strength in bending is not especially important.

Stress-Grades

A stress-grade is a grade in which each piece has a specified minimum strength expressed in terms of a safe working stress for permanent or long time loading; e.g., 1600lbf (1600 pounds per square inch in flexure) or 1200lbc (1200 pounds per square inch in axial compression). The grading rules for stress-grades are based on scientific engineering principles and painstaking research on the mechanical properties of wood and its growth characteristics. However, in the grading rules these engineering principles and research data are not expressed as such, but are translated into rules pertaining to physical characteristics such as density requirements and limitations as to size, kind and location of strength influencing factors—rules which are more readily understood and applied by the lumber inspector. The rules for a given stress-grade are not the same for all species, because the various species have different growth characteristics and mechanical properties.

The writing of grading rules for a stress-grade is an intricate process, based on the test strength of clear specimens of known density and many correction factors. In addition to factors of safety and requirements of use; e.g., as a beam or column, strength influencing characteristics such as density, seasoning defects which vary with the lumber size, cross grain, knots, shakes, checks, and wane must be considered. Decay in any form is usually prohibited in strength grades.

It is impractical for the average engineer or architect to attempt to write rules for a stress-grade: first, because in order to write intelligent practical grading rules he must make a thorough study of the mechanical properties of the wood, influence of defects on strength, growth characteristics of the species, commercial manufacturing processes and grading procedures; and secondly, because such specially prepared stress-grade is a non-standard item which requires special processing or selection by the manufacturer with its attendant increase in cost. The practical procedure is for the designer to adapt his design to one of the standard stress-grades.

The authenticity of a standard stress-grade may be assured by requiring either that the lumber be grade-marked or that a certificate of inspection be issued by the association under whose rules the lumber is graded.

(To be concluded in December)

HIGHWAY RESEARCH BOARD MEETS DECEMBER 4-6, 1940

The Twentieth Annual Meeting of the Highway Research Board of the National Research Council will be held in Washington at the building of the National Academy of Sciences the week beginning December 2.

Sessions of the Board will be held on Wednesday, Thursday and Friday, December 4 to 6. In addition, several departments of the Board will hold open meetings on Tuesday, December 3.

According to the tentative schedule released by Roy W. Crum, Director of the Board, the Departments of Design, Materials and Construction, Maintenance, Economics and Soils and the Committee on Roadside Development have scheduled meetings on Tuesday, December 3, which will be open to the public.

Board sessions will start Wednesday morning, December 4, with the discussions centered about materials and soils investigations. On Wednesday afternoon will come topics relating to highway economics; Thursday morning, traffic; Thursday afternoon, design and roadside development; Friday morning, finance and maintenance.

RECORDING SYSTEM FOR DIAGNOSING TRAFFIC ACCIDENT CAUSES

By E. L. ROBINSON

DETERMINED to diagnose correctly the causes of traffic accidents on the streets and highways of Los Angeles County, California, the county road department developed a unique recording system. From it can be picked the "accident prone" locations, areas, or stretches and their complete historical background obtained. Remedies can be prescribed accordingly.

Dealing with 4,273 miles of county highways, and 510 miles of State highways, M. J. Bankhead, County Traffic Engineer, has found the system invaluable in determining the cause of traffic accidents on the highways under the department's supervision.

The system, devised by Mr. Bankhead, is simple, complete, and accurate. On 66 detail maps of Los Angeles County, the engineer records accidents with metal bound discs placed on screw tagholders (Fig. 1). These maps are 5 by 7 ft. in size, and are drawn 600 ft. to the inch. As each accident occurs, the engineer places a screw tagholder at the location of the accident on the map. On this is hung a small white disc. On the back of the disc is a file number and a date. The file number refers to the detailed report on that accident.

For the first three accidents at any given location, the recorder hangs on another white tag. For accidents Nos. 4 to 6 he uses green tags, for Nos. 7 to 9 yellow tags, for No. 10 up, red tags. The maps show up danger zones at a glance. They facilitate analysis of accident conditions by providing instant reference to the detailed accident reports.

How the System Works

Here is an example of how the system works. Engineer Bankhead noticed in one of his experiments that an

Fig. 1.—Engineer Bankhead Examining One of His Tagged Wall Maps

Fig. 2.—Lighting Improvement at a Proven Danger Zone

appalling number of accidents have occurred at Lakewood Blvd. and South St. This intersection is in perfectly level, open country, where motorists should have been able to see each other easily. Nevertheless, one person had been killed and 47 injured in 25 reportable accidents in two years.

These accidents happened despite the use of 4-way reflectorized "stop" signs. An investigation of the accident records showed that 24 of the 25 accidents had taken place at night. Further investigation indicated that motorists came upon the "stop" signs unexpectedly and could not stop in time. A sodium vapor light was recommended for installation at this intersection to give drivers sufficient warning of the danger zone (Fig. 2). Warning markers were also placed 400 ft. in advance of the intersection on each road.

Whereas 24 out of 25 accidents occurred at this intersection after dark in two years before the above mentioned improvements, only two night accidents, have occurred in a period of 16 months since the improvements. Evidently the diagnosis was correct.

Colored Tags Tell Story

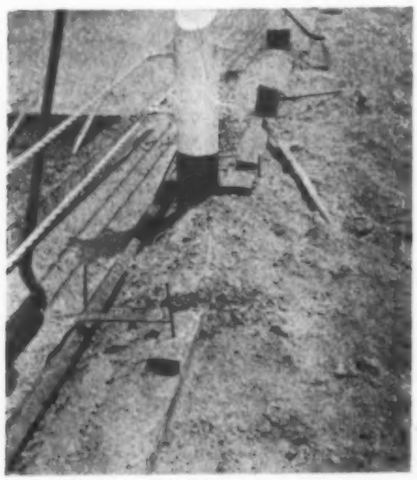
The Los Angeles engineer's system is enabling the traffic engineer to diagnose each danger zone whether it be intersection, curve, bridge head or continuous stretch, with actual facts based on accidents reported by the sheriff's office. When an intersection like Lakewood Blvd. and South St. gets spotted with red tags it calls for a different treatment than spots, areas or stretches with only white tags. And when complaints come in to headquarters asking for a specific corrective measure at a particular danger zone, Mr. Bankhead has immediate access to the accident history—and acts accordingly. His diagnosis, and treatment, will doubtless be more accurate and effective than that of the complainant.

Appointed Consultants to Public Roads Administration—Gilmore D. Clarke, Landscape Architect and Dean of the College of Architecture, Cornell University, and Jay Downer, Consulting Engineer of New York City, have been appointed as technical consultants to the Public Roads Administration of the Federal Works Agency. These consultants, when requested by Thomas H. MacDonald, Commissioner of Public Roads, will study special highway, bridge, and parkway projects and make reports with recommendations for their planning and development.

OBSERVATIONS BY THE WAY

By
A. PUDDLE JUMPER

¶ As you drive East from Boulder Dam in Arizona, you will notice some bituminous-mix curbs along the guard rail line. The picture herewith shows the formwork for making these curbs. All material was mixed,



placed and tamped by hand. The sloping board in the foreground shapes the face of the curb. The edge of the mixing box shows in the foreground at the left. The tamper is laying by the completed curb.

• •

¶ Another thing of especial interest in Texas is the highway department sponsored and managed engineering school they have established under the supervision of the construction department. So far over 370 engineers have taken the 6 weeks course. They plan now to put the contractors' superintendents through the mill. A grand idea which will prove economical to the state in the long run.

• •

¶ Montana scarifies worn surface treatments with FWD trucks as motive power for the scarifiers on the pull graders. They also use these trucks as motive power for trimming shoulders with pull graders.

¶ While he was at it, Milton Brown, senior detailer, Montana State Highway Commission, prepared a theoretical discussion on earth pressures. He states that the investigation of the supporting value of passive resistance of earth to lateral stability of buried or partially buried structures, such as piers, columns, power poles, lamp posts, etc., has led to some interesting results. Perhaps he hopes, some one may be sufficiently interested to make tests to check the results of the theory he presented.

Write him if you're interested.

• •

Write him if you're interested.

¶ It's a good thing that no ladies attend the banquet each year of the Texas A. & M. Highway Short Course. You guess why.

• •

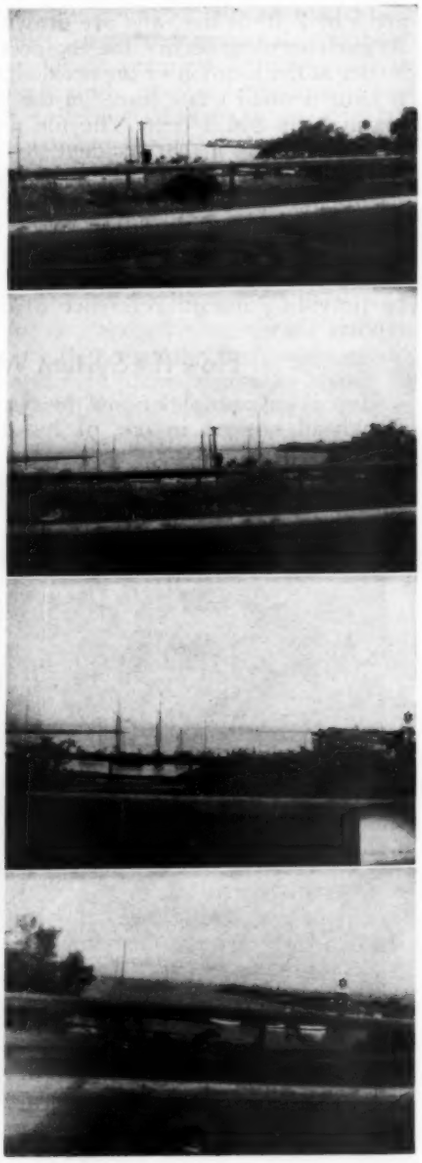
¶ Vancouver, Washington, cautions motorist with sign shown on telephone pole. I missed shooting another sign peculiar to this town. It read as

follows: "SIGNS OF PROGRESS" "Your Street Department." They were spotted around a local improvement district project.

• •

¶ The only electric street railway left in the State of Montana is at Anaconda. It runs between the town and the big smelter.

¶ Following is a letter, with pictures, from a former state highway engineer. Since an editor's sole reward is letters such as this, it is evident that this letter was a pleasure



to read. The editors of ROADS AND STREETS are on record editorially and otherwise in regard to the contents of Col. Crosby's remarks.

My dear A. P. J.:

You certainly were "tecknikle, Mable" in May! Now, to swing back to the other side:

Have you ever noticed how often the motorist does not get the view he anticipates (even if he is not doing the driving) because of the interference of the "guard rail"?

One expects grand views from some bridges, such as the "Golden Gate". Try and get it from a car.

I enclose some snapshots to show that roads are similarly marred.

If it is necessary [to build them as is —Ed.] for discouraging "jumpers", (not puddle) why not put the top rail up so that the rest of us can see under it?

Much consideration is being developed for adding to the comfort, safety, and enjoyment of highwaying. Here's a little but most irritating detail that seems to have been too often overlooked.

With best wishes

Cordially yours,
W. W. Crosby
(Coronado, Calif.)

There really are people on the beach behind the rail.

Four tries to see what's in the bay.

Here we got a section that needed repair, "suppressed." [Sounds like irony to A. P. J.]

• •

¶ By the effective placement of guard posts on curves and at bridge ends, each containing a reflector button properly and uniformly placed, Maintenance Engineer Hodges of Texas has, when striping is considered, effectively channelized traffic. Excellent work, Texas.

• •

¶ During the period May 1, 1939, to April 30, 1940, inclusive, the revenue from gasoline tax proper of the Province of Saskatchewan, Canada, was $2,999,873.77 as compared to $1,876,199.52 for the same length of time from May 1, 1938, to April 30, 1939, one year earlier. This happened when the Province used a dye in the gasoline in order to detect illegal use of tax exempt gasoline.

• •

¶ Again, I want to compliment Nevada on their smooth, wide bituminous road surfaces. While talking about Nevada, I noted that all the detours for construction work were paved. It received praise from motorists at the places I stopped for the night. A good idea—I hope it's a construction policy.

• •

¶ A good way for Colorado and its contractors to get justifiable criticism is for them to continue to tear up miles of road for construction and leave it rough and bumpy. Those long torn up stretches on U. S. 40 east of Rabbit Ears Pass is inexcusable. Why the engineers ever allowed the contractors to tear up so many miles is beyond reason. If I were you, Jim Kenney, I'd call my gang together and caution them about the loss of public good will (which they sorely need) when they sprawl their activities over such long stretches. It's a pain in the neck.

• •

¶ I'm not trying to Peglerize Colorado, but I can't help criticizing those bumps at the ends of their bridges. Maintenance men could well afford to run over and visit their Nebraska neighbors and learn how Nebraska prevents those bridge approach bumps.

• •

¶ Whether the bridge hand rail posts in Nebraska were specially designed to reflect headlamp light at night or not, I do not know. I do know, however, that they do an excellent reflecting job, clearly outlining every bridge.

• •

¶ And while I'm at it, I want to commend Nebraska for those easy grades, easy curvature, and smooth riding surfaces on U. S. 34 clear across the state. The directional signs, however, are far too small. I can't read them at 70 miles an hour.

• •

¶ Capt. Gleason of the Greenwich, Connecticut, police tells a good one on Capt. Ralph Buckley of the Connecticut State Highway Patrol during the opening, last Labor Day, of the Merritt Parkway Extension. He says (and Buckley was present) that state troopers were directing traffic down a road that led onto the Merritt Parkway, only, and localities found themselves confronted with a toll gate. They couldn't turn around on the Parkway since it is a violation of the law to do so; thus, were forced to pay toll.

Well—that's one way to make toll roads pay.

• •

¶ It has been suggested that frosted glasses be used in all traffic lights so there will be no reflection from the sun.

• •

¶ J. N. Bishop, maintenance engineer for Oregon, told me about a stunt he is trying out that may be of interest. He placed guard rail posts in a hole and tamped earth and road oil in alternate layers to fill the hole. He says it seems to have stopped rotting and loosening of the posts. He just pours the oil in the hole with loose dirt and tamps it.

¶ Julian Montgomery, former state highway engineer of Texas who resigned because of ill health, has gained 14 lb. and expects to get back in circulation by January first. His plans have not crystallized yet as to just what he will do. A. P. J. desires to remember him to his many friends.

• •

¶ During the height of the construction season this year the F. H. Freeto Construction Company set a new record in asphalt road construction. A transport driver picked up 3000 gallons of road oil at the Skelly Oil Company refinery at El Dorado, Kansas, and forgot to fasten the outlet valve securely. On arriving at Baxter Springs, some 175 miles from El Dorado, the driver discovered that the only asphalt he had was a few gallons which had not yet leaked out. The Freeto Construction Company had, in effect, laid an asphalt road 175 miles long in less than four hours' time. We think this is the world's record.

• •

¶ Utah has a 30 mile stretch of road without a curve. This is on U. S. Route 40 across the Bonneville Salt Flats near Salt Lake City.

• •

¶ North Dakota, in making an analysis of bridge and culvert costs for a 4-yr. period, 1935-1938, inclusive, learned the following interesting information:

Type of Structure	No.	Length in Ft.	Cost per Ft.
Steel I-beams and concrete bridges	4	370.5	$199.22
Treated timber bridges	5	368.5	112.39
Box culverts under 20 ft.	49	432.7	169.04
Box culverts over 20 ft.	36	793.0	170.74
Railroad grade separations:			
Overhead	20	4580.1	135.84
Underpass	10	1108.1	632.11

• •

¶ Another interesting note I found in North Dakota relates to reasons for retiring certain road surfaces. A review of the construction period, 1918 to 1936, indicates the following distribution of retirements:

Structural deterioration	3 percent
Functional obsolescence	6 percent
Combination of structural deterioration and functional obsolescence, when either one alone would have been insufficient reason to cause retirement	85 percent
Construction of related improvements (grade separations, bridges, etc.)	1 percent
Other facts (construction of dams, disasters, floods, etc.	5 percent
Total	100 percent

A mechanical rodeo, starring puppet cowboys that are one-third life size, is touring the West in a streamlined truck-trailer.

American Road

WASHINGTON, D. C.

PATRIOTISM, PARLEYS AND PLAY

Down the Road

by CHARLES M. UPHAM
International Highway Authority

MORE ROADS FOR WAR LOADS

America leads the world in mechanical progress. Machine developments in this country show the way to other nations. Gigantic construction projects, plus efficient industrial production, are the offspring of America's inventive genius. Machines have shaped the New World's way of life since the turn of the century. From the wheels of American industry—from the nation's construction expansion spring an unsurpassed standard of living, educational system, era of culture. American people thrill to the glories of a more brilliant civilization. This is the "Age of Technocracy". Its influence is felt around the world. Other nations call our engineers to help them—Russia, Turkey, China, Mexico and the Republics of South America. Production systems are organized. Good things from the good earth soon flow from mine, well and farm to the factory—from there to foreign ports. New riches are exchanged. The latent wealth and power of a nation is brought to the service of man.

Once devoted to the betterment of mankind, a half-century of concentrated mechanical progress now serves the Gods of War. Tanks replace tractors on the assembly line. Bombers supersede transocean planes, warships take precedence over merchant vessels. A state of national emergency exists. There is no real progress except where improvement benefits the national defense. Peacetime industry halts its forward march. There is one instrument of peace, however, that the War Department insists upon—the improvement and construction of good roads.

Mobilization of the nation's manpower and industrial energy for the cause of national preparedness also calls the road builders of America into the patriotic circle. The construction of better, safer, more durable, more modern highways—the building of stronger and more adequate bridges produce near-perfect motorized-army efficiency. The roads of America must be prepared—they must be made strong to meet the demands of any military eventuality. The machines and materials of American road building, therefore, take equal rank with military equipment and munitions as indispensable elements in the national defense.

Orders from the national preparedness program co-ordinators call for "full speed ahead" in the production of planes, ships, tanks, guns and other weapons of modern warfare. The same orders might well and wisely be given to the manufacturers of American road-building equipment. Road graders, pavers and all the other machines and materials of road construction may play a less dramatic role in the nation's defense, but their contribution to the preservation of the democratic way of living is no less important. Consider America's present emergency. While still at peace, the nation must prepare for war. National preparedness, therefore, takes the form of stepped-up production. This, in turn, necessitates the rapid transportation of raw materials and finished products from source of supply to place of demand. A great bulk of this transportation must take place by truck over the highway. At the same time, army maneuvers are conducted to train the nation's manpower. These troops must also be transported over roads. Already the peacetime demand on the national highway system has increased by leaps and bounds. A national lottery is calling America's largest peacetime army into service. Bulldozers, material mixers and spreaders and other tools of the highway industry must precede army occupation of designated training centers. Troops, tanks and trucks cannot function effectively or swiftly without all-weather roads.

The job of the American road builder does not stop with the outbreak of actual conflict. Roads torn up by army movement

Americanism has first place in plans for the 1941 Convention of the American Road Builders' Association at New York City, January 27-31. Road Builders will gather from the forty-eight states, and the Pan-American nations to learn how they can best contribute to America's safety and future welfare. "Roads for Defense," convention theme note, will be stressed during the five-day meet. Highway and military experts will join federal and local government officials in a roads-for-defense forum on the opening day. Representatives of the U. S. War Department and the National Advisory Defense Commission will be on hand for these deliberations. General sessions will be interspersed with special meetings of the Municipal, County Highway Officials', Contractors', Airport, Manufacturers', Planning, Highway Economics, Education, Pan-American and Public Relations Divisions. Convention headquarters will be the Pennsylvania hotel.

Star-studded entertainment, never surpassed in the 38-year history of the association, is billed for the annual banquet at the Waldorf-Astoria, January 29. Arrangements are being made to secure the appearances of leading stage, screen and radio stars to make the "Road Builders' Mardi Gras" top all previous banquet programs. A special song, dedicated to the Road Builders of America, is being composed by two of New York's outstanding songwriters for introduction at the banquet. Oscar of the Waldorf, world-famous chef, will preside over the delicacies served to conventionites against the glamorous background of the Waldorf's Grand Ballroom. Banquet tickets are now available from ARBA National Headquarters, International Building, Washington, D. C.

The ARBA Airport Division will sponsor an airport conference on January 29, in co-operation with the University of Michigan, the National Aeronautics Association, the American Association of Airport Executives, the Air Transport Association of America and the Aeronautical Chamber of Commerce. The Airport Division will also meet jointly with the County, Highway Contractors' and Municipal Divisions to discuss common problems.

More Roads for War Loads

or shattered by enemy attack require immediate repair. Men, materials and machines must be constantly at hand to rebuild roadways and construct bridges. The American Road Builder—his machines, his materials—belongs in America's first line of defense. The success of the combat force that follows depends upon his suc-

Builders' Review

NOVEMBER, 1940

The "Jeep", new 5-ton military tractor, can climb a 40-per-cent grade, ford a stream 40 inches deep and turn on a 20-foot radius.

TO HIGHLIGHT ARBA CONVENTION

DOWNS NAMED CONTRACTORS' DIVISION OFFICE MANAGER

Francis J. Downs has been appointed office manager of the ARBA Highway Contractors' Division. He succeeds William C. Slee, who is now devoting full time to his duties as manager of the ARBA Airport and Municipal Divisions. A native of Mercer, Pa., Mr. Downs was graduated from the Carnegie Institute of Technology at Pittsburgh with the degree of BS in CE in 1930. During the following six years he was associated with his father in building construction work at Franklin, Pa. He served the state highway department as construction engineer in 1937-38. He was later associated with the Public Works Administration as engineer-inspector and with the Pennsylvania Turnpike Commission as concrete placing inspector. His experience also includes employment by two private contracting firms, the J. & M. Doyle Co. of Erie, Pa., and the A. V. Williams Construction Co. of Middle River, Md. As Contractors' Division office manager, Mr. Downs serves as direct contact between the American Road Builders' Association and all its highway-contractor affiliated groups. He also maintains contact with the various government offices and awarding authorities in the Nation's Capital for the benefit of contractor-members.

SOURS SUCCEEDS BEIGHTLER AS OHIO HIGHWAY DIRECTOR

ARBA President Hal G. Sours has been named acting director of the Ohio Department of Highways. He succeeds Major-General Robert S. Beightler who left to head the Ohio National Guard on October 15. Mr. Sours, who was elected president of the American Road Builders' Association last January, has served as assistant director and chief engineer of the Ohio department for the past two years.

HIGHWAY CONTRACTORS' BOARD OF STRATEGY

Pictured above by "Highway Information Service" grouped about the desk of ARBA Engineer-Director Charles M. Upham is the Washington Board of Strategy of the association's Highway Contractors' Division. Left to right are Francis J. Downs, division office manager; Burton F. Miller, executive assistant to the engineer-director; Mr. Upham, William Ogden, division field manager, and A. E. O'Brien, division executive director. This group of experts constitutes the "business representative" of the highway contractor in the Nation's Capital.

TEXAS HIGHWAY WEEK PLANNED FOR DECEMBER

The Texas Good Roads Association is co-operating with the state highway department in sponsorship of Texas Highway Week, December 2-6. The program is designed to stimulate public interest in highways. Information will be disseminated concerning state and local highway problems and needs. Speakers will be supplied by the ARBA affiliate to discuss the highway program before meetings of civic organizations. Plans are being made to schedule a 15-minute talk each day on highway matters over two Texas radio networks. One of the main objectives of the week is to focus attention on highway deficiencies as a preliminary to submission of an anti-diversion amendment to the state constitution. This amendment will be sponsored by the TGRA at the next session of the state legislature, which convenes in January, 1941.

NEBRASKA ASSOCIATION AFFILIATES WITH ARBA

Affiliation with the American Road Builders' Association was voted by the Nebraska Good Roads Association at its annual convention in Grand Island, October 15. Officers of the new state group are Mark T. Caster, Lincoln, president; Harry F. Russell, Hastings, vice-president; Harry S. Byrne, Omaha, secretary, and Fay Wood, Seward, treasurer. William C. Slee, ARBA assistant engineer-director, spoke on superhighways at the convention. Other speakers included A. C. Tilley, Nebraska state engineer, on "Nebraska's Highways Come of Age"; President Caster on "Looking Forward"; F. H. Klietsch, Nebraska maintenance engineer, on "Highway Maintenance"; Professor Quincy C. Ayres, Iowa State College, on "Soil Erosion," and C. Coykendall, Iowa highway administration engineer, on "Accomplishment of a Highway Commission."

More Roads for War Loads

cessful efforts to pave the way. In peacetime preparedness and in actual combat, the man in the armored tank and the man in the road-building machine must work shoulder to shoulder. When normal times return, war machinery and road equipment can share the same parade. They will have served the cause of national defense with equal fidelity.

CONTRACTOR ON COUNTY WORK LEARNS VALUE OF CLOSE ENGINEERING CONTROL

On Densely Graded Local Materials Mixed in Traveling Roadmix Plant

By CHAS. R. HAILE and WILLIAM W. McCLENDON

Consulting Engineers, Houston, Texas

TODAY, in the enthusiasm we encounter for the employment of local materials in the various bituminous mixtures for road surfacings, we see evidence that old mistakes of bituminous mat construction will be made again. Successful jobs have led others to follow, often without sufficient study and engineering control. In many cases, engineering and laboratory control of construction work is considered as unnecessary expense.

Left to Right: Chas. Haile; D. T. Austin of Haden and Austin, Contractors; and W. W. McClendon

Preliminary Work

A project finished this spring under our supervision in Fort Bend County, Texas, consisted of 34.21 miles of road. Six and one-half miles were set up in the original plan to be surface-treated gravel roads and 27.69 miles to be plain gravel surface. A very early dead line was set for the beginning of work. We were employed as consulting engineers by Fort Bend County, and had barely 2 months to prepare plans and to get the work under way.

We were not satisfied with the project as it was originally set up, especially in view of the fact that no satisfactory road gravel was available locally and that all materials, or a greater portion of them, woud have to be shipped in. To meet the dead line, however, we did not have sufficient time to make satisfactory studies; so in order to get the project under way without sacrificing the loss of some of the funds, we selected 5.116 miles on lesser important roads, drew up plans and let the contract for a gravel surface as was contemplated in the original set up.

Since the cost per mile of a gravel surface 8 in. thick (loose) by 18 ft. wide was actually $7,168.00, we first secured permission from the Bureau of Public Roads to let contracts as above and to continue our investigations toward securing a higher type of surface on the balance.

Since there had been no previous dense graded local material project constructed in this area, we had no pattern to guide us in the determination of the suitability of local materials or the amount and kind of asphalt that would give us a good stable surface. To start investigations we had to review our knowledge of asphaltic pavements, study all reports and papers available on the subject, and use common sense.

After investigation, it was determined that the sandy gravel obtained from the river bed of the Brazos River in Fort Bend County would be a satisfactory material for a bituminous mix if sufficient fines could be found and added for filler. We found this filler material in sand dunes near the site of construction. As the roads to be constructed lay in all parts of the precinct, five select material pits were used for the job.

The gravelly material from the river we designated as course aggregate. The select material was designated as fine aggregate. We found that we could limit the number of combinations of coarse aggregates with fine aggrgates from the different pits to to two and maintain a fairly uniform material. For several of the select materials, the ratio of coarse aggregate to fine aggregate was 3:2; for the others 3:1.

The average results of the two above combinations made with different select materials gave us the following minimum and maximum grading of mixture:

	Minimum Per Cent	Maximum Per Cent
Passing 2 in. screen—Retained on 1 in. screen	.6	.75
Passing 1 in. screen—Retained on ½ in. screen	2.4	3.0
Passing ½ in. screen—Retained on ¼ in. screen	7.8	9.75
Passing ¼ in. screen—Retained on 10 mesh sieve	11.4	14.25
Passing 40 mesh sieve—Retained on 80 mesh sieve	18.25	35.2
Passing 10 mesh sieve—Retained on 40 mesh sieve	25.8	32.0
Passing 80 mesh sieve—Retained on 200 mesh sieve	9.25	16.25
Passing 200 mesh sieve	4.2	10.0

From our knowledge of design of asphaltic paving mixtures we decided to use the "Burn's Band Method for Asphalt Paving Design" in determining the bitumen content. This method determines the bitumen content for various types of aggregate of different gradations for bituminous surface courses.

A copy of the table, with curves, is shown herewith as Fig. 1. Since bituminous surfaces as a general rule are of a thickness not in excess of 2 in., we were of the opinion that the bitumen content determined directly by this method would give an excess of bitumen when used in a thicker base course. With this in mind, we arbitrarily started our experiments, using 80 per cent of the theoretical surface bitumen requirement as determined by the Burn's Method.

We decided that on such a large job a machine mix was cheaper than blade mixing. With a machine mix, we would be able to use rapid curing cut backs and harder asphalts, both of which, we believed, assured a better job than the slow curing road oils that were being used in road mixes. Cost, high humidity, and sub-soil condition of the coast section influenced us in choosing the

HIGHWAYS FOR

NORMAL PEACE-TIME NEEDS | OR NATIONAL DEFENSE

GET BOTH WITH
a balanced asphalt highway plan

● There are a great many reasons for putting highway and airport construction plans in gear with the stepped up pace of army mechanization. Roads, bridges and airports are vital to a fully mechanized army. But these same facilities are of almost equal importance to the development of any community highway system in peace time.

For instance, an adequate system of secondary roads for defense makes it possible to move troops into an area while evacuating civilians. But these same secondary roads in peace time would relieve the Sunday and holiday traffic on main highways.

The National defense program has added the need for *speed* in developing *more* highways at *low cost*.

Consider these facts, whether you are planning "defense" highways or your regular program. There are many types of asphalt construction. After considering local traffic requirements, soil conditions and available aggregates, you can pick the type that is most economical for your need. Fast, safe all-weather surfaces can be laid quickly—roads or airport runways are out of service but a short time. Asphalt surfaces are easily maintained and you get the maximum mileage for your money.

Adequate stocks of all types of asphalt are available throughout the Middle West. Write to Standard Oil Company (Indiana), 910 South Michigan Ave., Chicago, Illinois. In Nebraska, call or write Standard Oil Company of Nebraska at Omaha.

Asphalt for every purpose

STANDARD OIL COMPANY
(INDIANA)

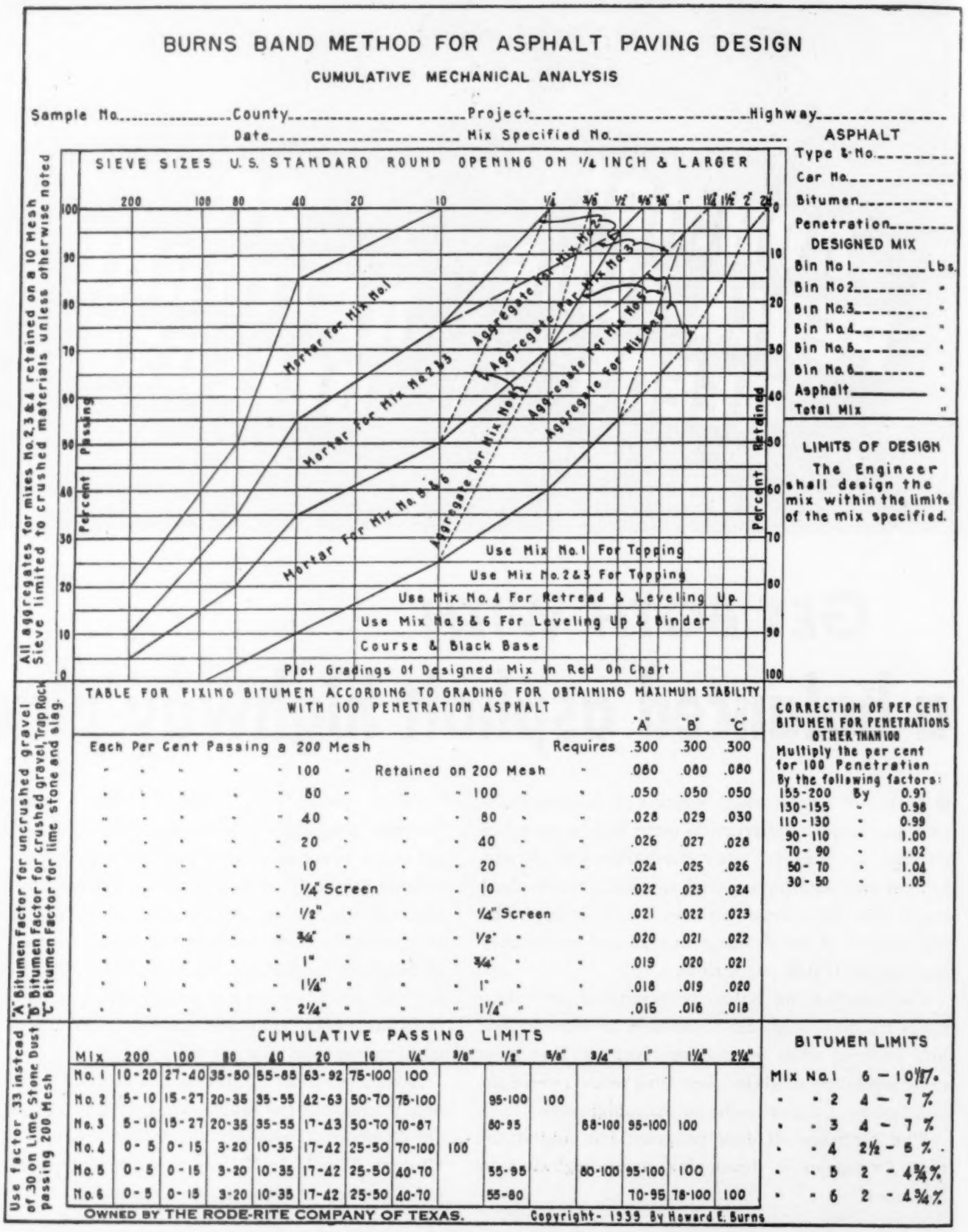

BURNS BAND METHOD FOR ASPHALT PAVING DESIGN
CUMULATIVE MECHANICAL ANALYSIS
Sample No. County Project Highway
Date Mix Specified No.
ASPHALT
Type & No.
Car No.
Bitumen
Penetration
DESIGNED MIX
Bin No 1 Lbs.
Bin No 2 "
Bin No. 3 "
Bin No. 4 "
Bin No. 5 "
Bin No. 6 "
Asphalt "
Total Mix "
SIEVE SIZES U.S. STANDARD ROUND OPENING ON 1/4 INCH & LARGER
200 100 80 40 20 10 1/4 3/8 1/2 5/8 3/4 1" 1 1/4 1 1/2 2" 2 1/2
All aggregates for mixes No. 2, 3 & 4 retained on a 10 Mesh Sieve limited to crushed materials unless otherwise noted
Percent Passing
Percent Retained
Mortar for Mix No. 1
Aggregate for Mix No. 1
Mortar for Mix No. 2 & 3
Aggregate for Mix No. 2
Aggregate for Mix No. 3
Aggregate for Mix No. 4
Mortar For Mix No. 5 & 6
Aggregate for Mix No. 5
Aggregate for Mix No. 6
Use Mix No. 1 For Topping
Use Mix No. 2 & 3 For Topping
Use Mix No. 4 For Retread & Leveling Up
Use Mix No. 5 & 6 For Leveling Up & Binder Course & Black Base
Plot Gradings of Designed Mix In Red On Chart
LIMITS OF DESIGN
The Engineer shall design the mix within the limits of the mix specified.
TABLE FOR FIXING BITUMEN ACCORDING TO GRADING FOR OBTAINING MAXIMUM STABILITY WITH 100 PENETRATION ASPHALT
"A" Bitumen Factor for uncrushed gravel
"B" Bitumen Factor for crushed gravel, Trap Rock
"C" Bitumen Factor for lime stone and slag.
Each Per Cent Passing a 200 Mesh Requires .300 .300 .300
100 Retained on 200 Mesh .080 .080 .080
80 100 .050 .050 .050
40 80 .028 .029 .030
20 40 .026 .027 .028
10 20 .024 .025 .026
1/4" Screen 10 .022 .023 .024
1/2" 1/4" Screen .021 .022 .023
3/4" 1/2" .020 .021 .022
1" 3/4" .019 .020 .021
1 1/4" 1" .018 .019 .020
2 1/4" 1 1/4" .015 .016 .018
CORRECTION OF PER CENT BITUMEN FOR PENETRATIONS OTHER THAN 100
Multiply the per cent for 100 Penetration By the following factors:
155-200 By 0.97
130-155 " 0.98
110-130 " 0.99
90-110 " 1.00
70-90 " 1.02
50-70 " 1.04
30-50 " 1.05
Use factor .33 instead of .30 on Lime Stone Dust passing 200 Mesh
CUMULATIVE PASSING LIMITS
Mix 200 100 80 40 20 10 1/4" 3/8" 1/2" 5/8" 3/4" 1" 1 1/4" 2 1/4"
No. 1 10-20 27-40 35-50 55-65 63-92 75-100 100
No. 2 5-10 15-27 20-35 35-55 42-63 50-70 75-100 95-100 100
No. 3 5-10 15-27 20-35 35-55 17-43 50-70 70-87 80-95 88-100 95-100 100
No. 4 0-5 0-15 3-20 10-35 17-42 25-50 70-100 100
No. 5 0-5 0-15 3-20 10-35 17-42 25-50 40-70 55-95 80-100 95-100 100
No. 6 0-5 0-15 3-20 10-35 17-42 25-50 40-70 55-80 70-95 78-100 100
BITUMEN LIMITS
Mix No. 1 6 - 10 1/2 %
" " 2 4 - 7 %
" " 3 4 - 7 %
" " 4 2 1/2 - 5 %
" " 5 2 - 4 3/4 %
" " 6 2 - 4 3/4 %
OWNED BY THE RODE-RITE COMPANY OF TEXAS.
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Fig. 1.—Burns Band Method for Asphalt Paving Design. This Was Printed by Permission of the Copyright Owners

cut-back asphalt as being best suited for our purpose and use.

Preconstruction Testing

Local laboratories were not equipped to run stability tests and time did not permit sending samples to laboratories outside of Houston. This meant that the proportions of the materials to be used to obtain the most stable product must be determined by comparaitve tests. We

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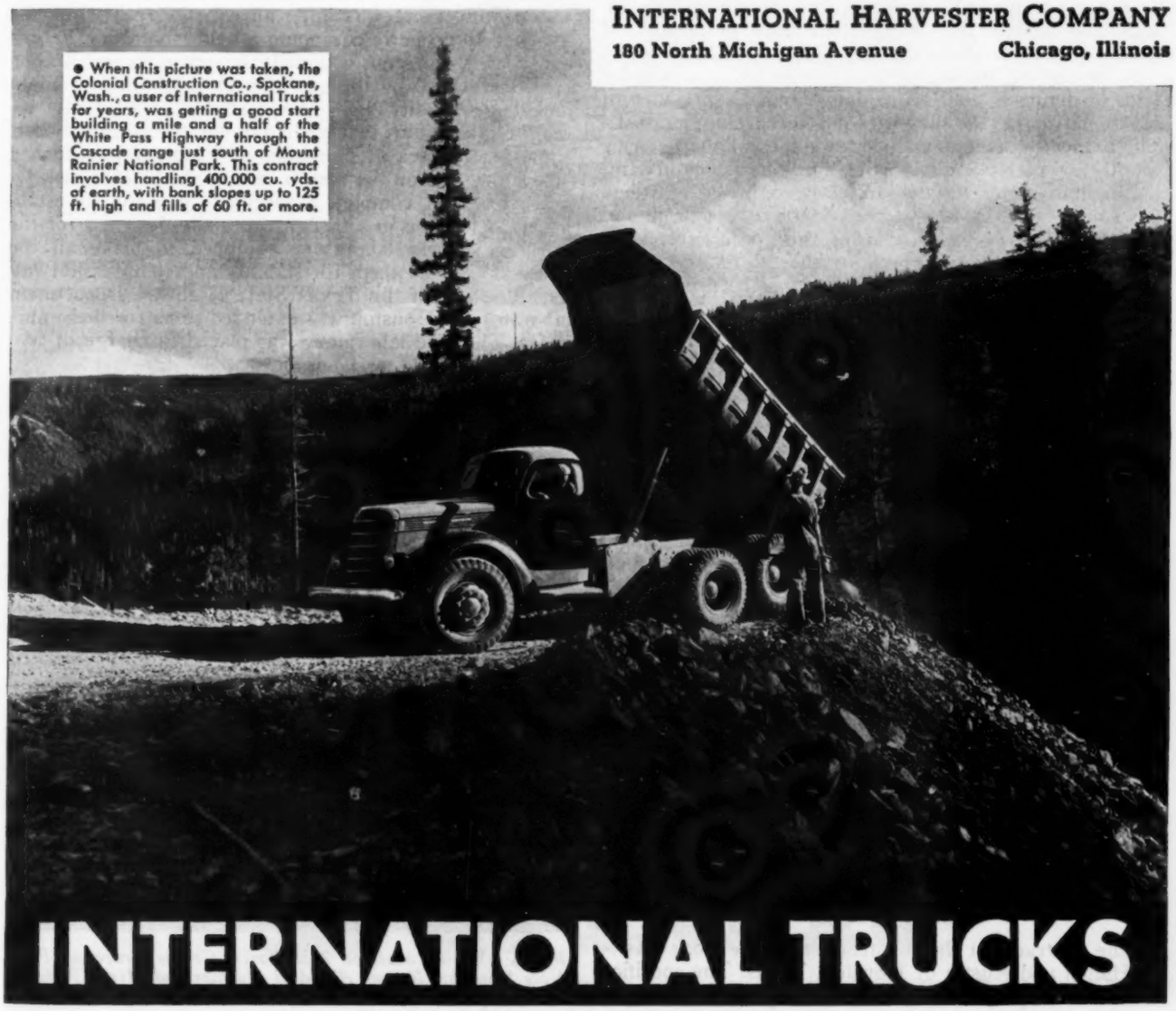


● When this picture was taken, the Colonial Construction Co., Spokane, Wash., a user of International Trucks for years, was getting a good start building a mile and a half of the White Pass Highway through the Cascade range just south of Mount Rainier National Park. This contract involves handling 400,000 cu. yds. of earth, with bank slopes up to 125 ft. high and fills of 60 ft. or more.

made up batches of different mixtures, using different gradings of aggregate, different bitumen contents, and different kinds of asphalt for testing.

In cooperation with Mr. M. M. Wooden of the Southwestern Laboratories the following method for making

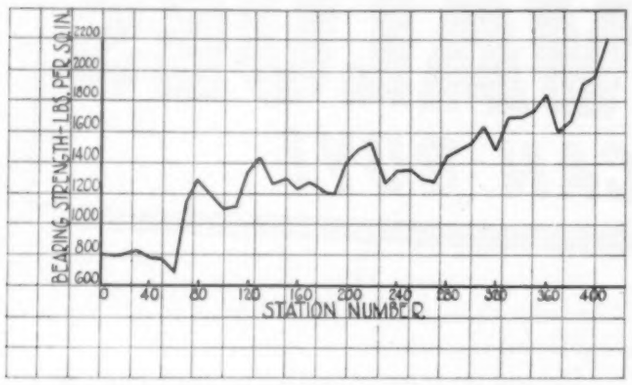


Fig. 2.—Results of Compaction Tests, Showing How Bearing Strength Increased With Closer Engineering Control and On Sections Where Solid Base Was Available

preliminary test was devised: Except in the matter of equipment, it follows substantially the standard stability test. After the samples had been thoroughly mixed, using the mixes previously determined, they were heated to 200 degs. and held at this temperature until practically all volatile matter had been driven off.

After cooling, the sample was compacted in a cylinder 2 in. in diameter and 2.2 in. long, under a pressure of 225 lb. per sq. in., the samples being compressed against a flat surface by using a piston inside the cylinder. A ring was then centered under this piston with a hole in same 1½ in. in diameter and the samples were pressed through this smaller opening at the rate of 0.05 in. per minute.

There was no reason for using this speed except that it happened to be the speed of the laboratory's compression machine, and so long as the same process was followed for all samples, we felt that as a comparative test the rate of speed would make very little difference.

From the tests made it developed that the heavier asphalt, Texaco RC3, gave the higher values, so this grade of asphalt was decided upon. We requested and received approval of the Bureau of Public Roads, to change the type of surfacing on the remaining 30.662 mi. of the project from a gravel surface or surface-tested gravel to a dense graded bituminous mix base, with a seal coat to prevent ravelling. Our estimate showed that we would be able to construct such a surface using a 3/10 gal. per square yard seal coat with crushed limestone cover material and keep within available funds. The thickness of the completed base varied from 4 in. to 8 in. loose measurement, depending upon the type of subgrade encountered.

All facts and figures of the above investigations were submitted to the Bureau, and their approval was given with the understanding that the lowest residual bitumen content was to be 3.49 per cent. This proviso was accepted so as to get the work under way, but investigations were continued as we felt that equally as good or better results could be secured with a lower residual bitumen content especially in view of the fact that the completed surface was to carry a seal coat.

Construction Starts

The contract for the construction of the work was let to Haden and Austin of Houston, Texas. The specifications on the project called for mixing operations to be done with a heavy duty traveling asphalt plant. A Barber-Greene plant with a mixing capacity of 1½ to 2 cu. yds. per min. was obtained.

The work on which the contract was let was on nine county roads. Some sections of these roads had an old gravel surface, others were well graded and drained. The original specifications called for the top 1 in. of existing gravel to be scarified and incorporated with 3 in. of new gravel so as to form a 4 in., loose measurement, asphalt mixed base. On the graded earth sections, gravel and select materials were combined, so as to form loose measurements of 5 to 8 in. in thickness.

The crown width averaged 30 ft. and the surface width was 18 ft. for the full thickness of materials. An additional 1 ft. on either side being placed to feather-edge the material to a minimum thickness of 1 in.

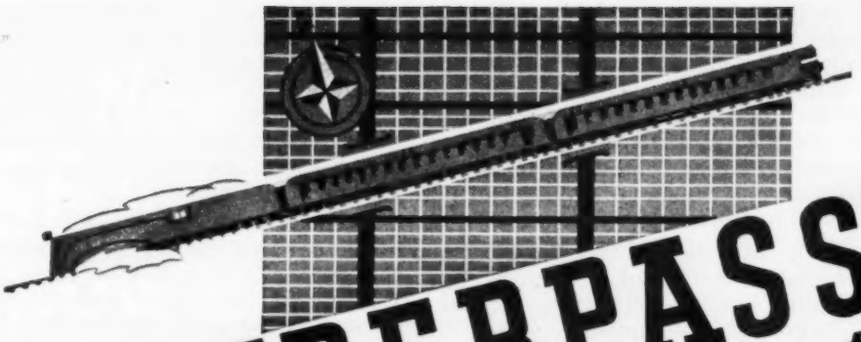
Due to our experimenting in getting the machine regulated and our unfamiliarity with it, our first day's run resulted in a short section of surface with a 2 per cent bitumen content and others with as much as 6 per cent. From comparative stability tests made on these sections, it was very evident that it would be possible to reduce the minimum bitumen content that had been established by the Bureau of Public Roads and at the same time secure an equally good or a better base at a cost of thousands of dollars under what had been anticipated, provided we could be assured of the very closest of laboratory control in the field.

Naturally there was quite an expense that would be attached to properly equipping a field laboratory, an expense which was not originally set up or expected. The results obtained by the use of such a laboratory would in all probability be unnoticeable. Consequently we realized at the start that we had to sell the commissioner's court on the idea of equipping and maintaining such a laboratory and on the results that might be obtained.

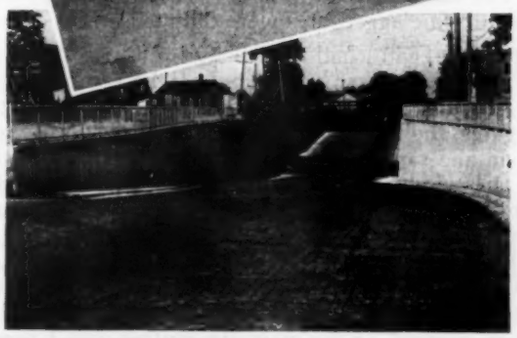
On receiving complete authority to proceed, we established and set up in a trailer, especially designed for the purpose, a field laboratory equipped to make all the necessary tests, except for stability and compression values. The use of the Texas State Highway Department laboratory in Houston was extended to us for these purposes. The field laboratory was placed in charge of Mr. W. J. Greenwald, as laborant.

We prepared record forms and organized to exercise every necessary control on the work, as we felt that we were on the spot and that the future construction of this

Fig. 3.—Mixing Machine Was Barber-Greene Traveling Plant. Note Windrow Evener Ahead of Machine and Mixed Windrow Sealer Behind Machine



FOR UNDERPASSES ...where traffic is brutal



(Top) *Big Four on U. S. 40 near Columbus, O.;* (Center) *Atlantic Coast Line, Bainbridge St., Richmond, Va.;* (Bottom) *Sangamon Ave., Springfield, Ill.*

● **Underpasses impose unusual and severe service conditions on pavements. Pave them with brick.**

Concentrated Traffic

On underpasses there is a concentrated traffic of both trucks and fast moving vehicles. Often there is street car traffic. Repairs to pavement in this vital spot discommodes traffic for miles around and means using hazardous grade crossings. Brick pavement can stand the punishment, without failure.

Unusual Moisture Conditions

Then there are unusual moisture conditions and poor drainage due to depressing the grade to obtain headroom. A brick surface is non-absorbent—moisture and freezing do not affect it. Moisture is sealed away from the base. Brick protects against damage from the elements as well as from traffic.

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BRICK

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type of pavement in this section would be materially affected by the results we obtained. As a result of this field control and daily studies made, we were able, before the work was less than one-third completed to submit to the Bureau of Public Roads facts substantiating our belief that with the available materials we could produce a satisfactory pavement with a residual bitumen content of less than the 3.49 per cent minimum requirement on which the specifications had been approved.

The net result of the tests showed that the greatest stability as determined by the Proctor needle test was obtained with a residual bitumen content of approximately 3 per cent. Accordingly we requested a change in the specifications, setting the limiting values of the residual bitumen content at a minimum of 2.5 per cent and a maximum of 3.5 per cent. The Bureau approved this change. As a result we were able to make not only invisible savings, due to a superior type of road far in excess of the expenditure on laboratory equipment and operation, but visible savings of thousands of dollars. It was practically enough to pay the entire engineering cost.

Construction Difficulties

In a general way, we will set out below the actual practice followed in the laying of the bituminous-mix base. Having previously determined the required amount of gravel, it was hauled and distributed on the road in dump trucks and windrowed at the side of the road. After the gravel was hauled, the required amount of select material was then hauled and placed in a windrow, on the opposite side of the road. Special care was exercised by the inspector in seeing that the proper amount of materials were hauled and dumped within each station. In face of all protests made by the contractor, his superintendent, the trucking contractor and individual truck drivers, they were required to reconstruct their truck beds, so that they were perfectly level on top. They were required to strike off their trucks at the job, so that the amount of material dumped was exactly the correct amount. Any surplus material on the truck was discarded and any shy truck rejected in full. Especially was this inspection rigid after mixing of asphalt had begun. We soon found that a surplus or excess of material on any section caused variations in excess of stipulated tolerances, as we were attempting to control the work. It produced considerably more argument than was encountered in getting the materials correctly placed at beginning. The subgrade had been properly shaped before the coarse and fine aggregates were dumped on it.

After aggregates had been placed, the two types were then brought together and mixed by the use of powered blade graders. Following the thorough mixing of these aggregates, the material was windrowed in the center of the road and samples of the mixed aggregate were taken from the windrow at thousand-foot intervals to check the grading of the combined mix, the desired grading of which had been previously established for this road section. Every effort was made to maintain a uniform grading within reasonable limits. Tests were made to determine the unit weight of the material, and the moisture content. If the moisture content was 3 per cent or less over saturated and surface dry condition, as set out in the specifications, the material was ready for mixing with the cut-back asphalt.

At this point it would be well to state that there is now and has been much discussion among engineers, contractors, and material men as to whether or not the percentage of moisture in the materials ahead of the machine affects the results to be obtained behind the machine; and this was a bone of much contention on our project. While we adhered strictly to the specifications and did not permit the mixing of the materials with asphalt until the moisture content was 3 per cent or less, we did on certain short sections of road, for experimental purposes only, and where we felt the conditions justified, mix materials with the moisture content in excess of 3 per cent up to a maximum of 6 per cent.

The actual result of this increase in allowable moisture in the aggregate ahead of the mixer was that, whereas the contractor had howled about being held up from working too long after every shower, the howl about drying out the additional moisture behind the mixer before he could lay it down and roll was greater. After a few trials he much preferred to get rid of moisture in the aggregate ahead of the mixer than to stand the increased delay, work, worry and anxiety about the weather, caused by extra drying of the mixture behind the machine. Generally the contractor was glad to wait after a rain until the moisture in the materials was considerably below the 3 per cent before starting mixing operations.

When the test for moisture content ahead of the mixer showed that the materials were within the allowable maximum specified, the contractor was required to pull a windrow evener, which we consider essential, over the material to bring the windrow to a uniform cross section. Rains and showers in this locality were frequent, sometimes lasting for only a few minutes, but being of sufficient intensity to thoroughly saturate the windrow. This necessitated the respreading of material with blades, drying it out and windrowing again, causing a delay of many hours often during sun-shiny weather. To overcome this condition the contractor secured Sisalkraft paper and kept the windrow covered for practically a day's run ahead of the machine. This worked very satisfactory.

When the materials were ready for mixing with the asphalt and all necessary tests had been made to determine the percentage of asphalt to be used, the controls on the machine were properly set so as to deliver the mixed materials with the correct asphalt content, and the contractor was permitted to start mixing operations.

After the materials had been mixed, samples of the completed mixture were taken at the same stations from the mixed windrow as were taken prior to mixing and by the use of the rotarex, the bitumen was extracted as a check on the work; and at hourly intervals the mixer inspector, Mr. J. H. Burton, was furnished with a result of these tests.

It might be stated here that the mixer inspector was furnished the results of the test made in front of the machine, and was required to make the calculations at the job for the percentage of bitumen required. Our check on him was in the results the laborant secured from tests of the material behind the machine. This method of operation proved successful; and the inspector, with the information furnished him, was able to maintain an almost perfect control.

After the material was mixed and discharged in a windrow behind the mixing plant it was again spread by means of blade graders, and aerated by frequent manipulation to expedite the evaporation of the volatiles.

The amount of volatile that should be left in the mixture at the time that it is finally compacted is probably one on which none of us agree unless it is the authors of this paper.

Arguments About Volatiles

We were of one accord, and we felt that the road would unquestionably be more stable if it was free from

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Fig. 4.—Tank Cars and Home Made Heating Equipment for Removal of Asphalt

all volatiles at the time the mixture was laid. At first we did not know just how free of volatiles the mixture could be and still be sufficiently workable to shape to section. On the first short section of the road that was built, we permitted the contractor to lay the materials within 24 to 48 hrs. from the time they were mixed. The volatile content of these materials was about 10 per cent, and we gradually began to work downward to see just how low we could go. This brought on much argument between the contractor and the engineers. The arguments, becoming violent at times, always ended up with the contractor doing what the engineer wanted (and what else could he do?), both leaving the job the same good personal friends they always have been and are today.

Samples were taken each day at the same station at 1,000 to 2,000 ft. intervals and tests made to determine the volatile content in the mixture. The contractor was furnished the results of these tests and not until, as little as one may believe it, the volatile content had been reduced to ½ of 1 per cent or less, was the contractor permitted to begin laying the pavement.

Would it be doubted then, that the arguments in regard to these matters at some times became violent? The contractor at first thought that it would be physically impossible to lay the pavement with such a low volatile content because of the hardness of the asphalt, and furnished us with telegrams and other data from contractors and engineers from the Atlantic to the Pacific Coast, saying that such conditions could not be complied with. We were firm in our convictions, however (and remember that we are talking about our job and ours only), that this was the only way on which the desired results could be obtained.

On the first few miles of the road we had been furnishing the contractor with the results of our tests, showing the amount of volatile in the material on a percentage basis. This brought on many arguments due to the fact that we calculated one way, the contractor's foreman or superintendent calculated another way, and the contractor himself calculated still another. We did not blame him for kicking when he wasn't permitted, on road after road, to lay the materials until sometimes as much as two or three weeks after they had been mixed, the delay being caused by the fact that he was definitely required to reduce the volatile content to the amount set out above.

Because of these differences of opinion as to the amount of volatile content calculated on a percentage basis, we could improve relations and eliminate arguments if some simple means could be found whereby the extent of volatiles could be determined by a visual method as well as by percentage; and after much experimentation, we devised the following method:

An ordinary 16-qt. galvanized bucket equipped with a cut-off spigot was hung from the ceiling of the laboratory, filled with ice and water and connected with a ⅜-in. rubber tube to the bottom of a vertical condenser, the top of this condenser being connected by a tube to another 16-qt. galvanized bucket on the floor, for collecting any over-flow. The condenser was connected at the bottom, through a dilution trap fitted with corks, to a three thousand millititer round-bottom pyrex flask. The trap showed the presence and percentage of volatiles at a glance.

The use of this method gave the contractor visible evidence as to whether there were or were not volatiles in the mixture; and after we began the use of this equipment for the determination of their presence, there was only one argument of any violence on the subject.

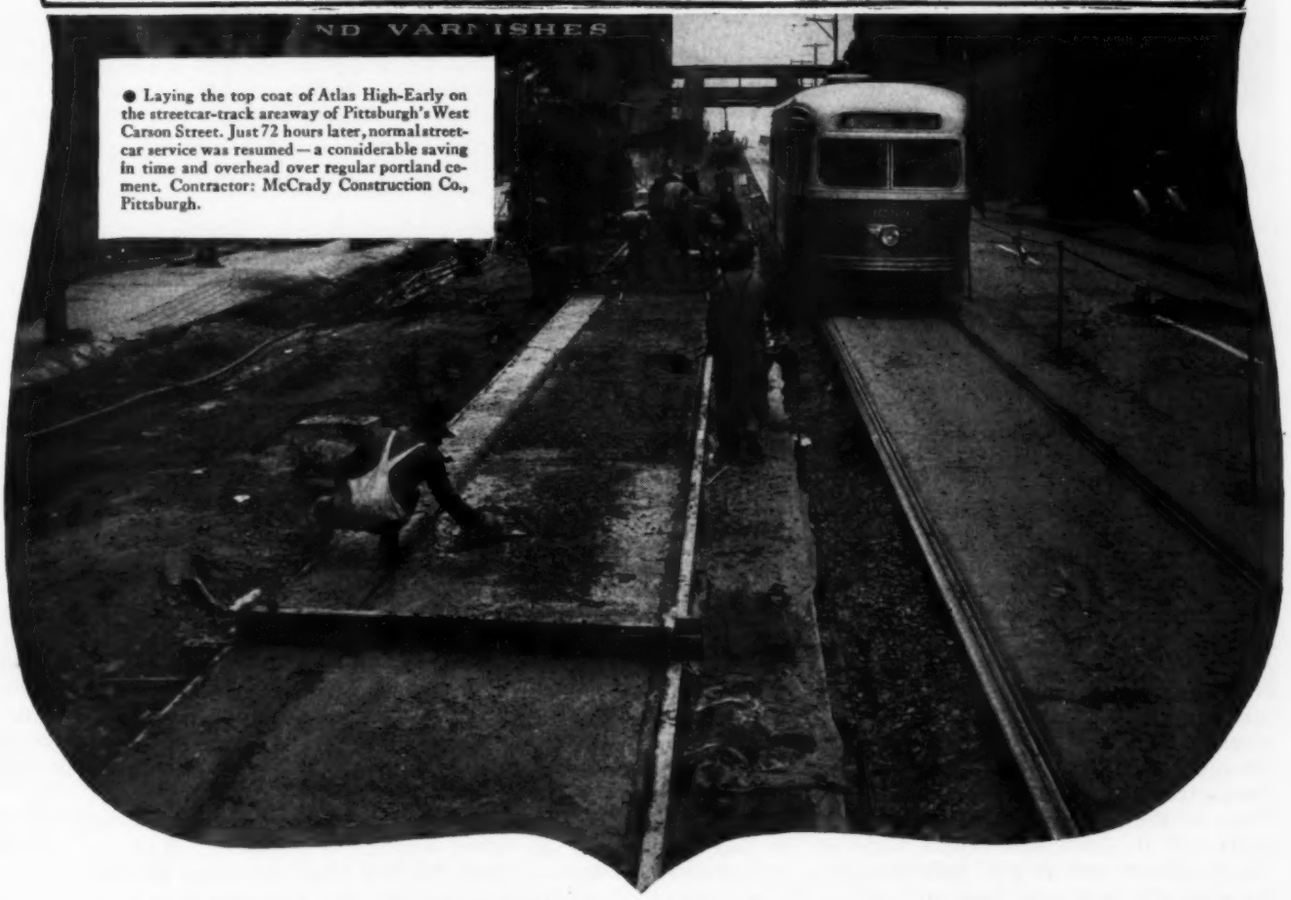
A Showdown

By this time we felt justified and secure in our contentions, and when the contractor still insisted he could lay the pavement and produce the results required with less aeration than we required, we very courteously closed the laboratory, pulling our mixing inspector off the job, and gave the contractor full authority to proceed in any way that he saw fit, in putting the surface down. We would not undertake to bother him in any way or to hinder his operations or to tell him what to do or what not to do. There was only one proviso and that was that we would make no tests whatsoever on the road until the surface was laid, at which time we would make tests on the completed pavement, and if the results obtained complied with the contract, we would be more than glad to pay him for the job. We knew that he was aware of the fact that the control up to this time had been giving perfect results ahead of and behind the mixer. With this admonition, after closing the laboratory in the middle of the day, we and our inspector left the job on the friendliest terms with the contractor.

This operation by the contractor continued for probably a day and a half, when we were called on the phone and requested to come back on the job, re-open our laboratory and bring our inspector with us. On reaching the job, we found that Mr. C. A. Wood, Superintendent for the contractor, in his jovial way had erected a white flag on top of the asphalt plant. It was floating in the breeze and on it the inscription, "War is Over." From that time on, argument ceased. After about 2 weeks' time the surface laid while we were absent, though apparently thoroughly compacted, began to crack and rut. Investigation showed that the evident cause of the failure was ex-

Fig. 5.—Windrow Evener Meters Out Aggregate Ready for Mixing Plant

HOW WEST CARSON STREET GOT ITS FACE LIFTED—*QUICKLY*



● Laying the top coat of Atlas High-Early on the streetcar-track areaway of Pittsburgh's West Carson Street. Just 72 hours later, normal streetcar service was resumed—a considerable saving in time and overhead over regular portland cement. Contractor: McCrady Construction Co., Pittsburgh.

Only 72 hours after concreting the track area with Atlas High-Early Cement—streetcars go back into service. Result—contractor speeds up whole repairing job.

PENNA. U.S. 30 (LINCOLN HIGHWAY)
PENNA. U.S. 22 (WM. PENN HIGHWAY)
W. CARSON ST. (PITTSBURGH'S W. CARSON ST.)

WEST CARSON STREET in Pittsburgh is also a section of the Lincoln Highway (U. S. 30) and the William Penn Highway (U. S. 22.) You know what it means to repave in the face of frequent streetcar schedules and heavy local and interstate truck and auto traffic.

But the contractors found a speedy solution. They saved many days' time by using Atlas High-Early cement in the streetcar-track areaway. They laid the base course one day. They followed with a 4-inch topping the next day. After curing two days and confirming the strength of the concrete by beam tests, they ran their mixer on the streetcar tracks and started placing the regular portland cement concrete roadway.

Seventy-two hours after placing the track area top coat, streetcars ran freely over the Atlas High-Early concrete. Repaving of the whole street was speeded up tremendously. Quick resumption of streetcar operation helped to reduce automobile and truck congestion.

If you face a street or highway job—the construction of a bridge or a building—particularly a job where speed is essential—specify Atlas High-Early cement. Write today for an informative new folder, "Case Histories of Days and Dollars." Universal Atlas Cement Co. (United States Steel Corporation Subsidiary), Chrysler Building, New York City.

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RS-H-E4

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Fig. 6.—Close Up of Discharge End of Road-Mix Travel Plant Showing Device for Smoothing Top and Sides of Mixed Windrow So Water Will Run Off

cessive volatiles that had been sealed in by rolling. The contractor, of his own volition, and without any request or suggestion whatsoever on our part, had to take up about a mile and half of pavement, which he had laid during our absence with the proper bitumen content, but a volatile content of 4 to 5 per cent. This occurred when not quite half of the total amount of work to be done, had been completed.

Whether we were a little too exacting in requiring the elimination of all volatiles and of moisture in the mixture before the surface was laid, and whether a reasonable per cent of volatiles could have been left in the mixture when it was sealed and compacted may be debated. We believe in this case, however, that there would have been some failures, and that we were fully justified in the efforts to which we went to secure a surface devoid of volatiles or moisture.

It should be said in justice to the contractor that the principal cause of his impatience to roll and seal the surface was not only the extra work of stirring and aerating, but the ever present danger of rains softening the subgrade. To overcome this condition we permitted the contractor to spread a very thin layer, not to exceed 1 in., of the mixture over the entire subgrade and let traffic roll it. Additional layers could not be laid until this first layer was free of volatiles. This waterproofed the subgrade, kept rains from softening it and we believe saved him more than his cost of additional aeration. It did not affect the ultimate surface, as we rolled the surface in layers with a pneumatic tired roller, beginning at the edge and working toward the center. We started with the roller loaded to a compression of about 200 lb. per sq. in. and worked up to 325 lb. per sq. in. in the final rolling.

Tests Before Sealing

Before placing the seal coat, samples were taken from the road and compaction tests were made with the Proctor needle. Ten tests were made at each 1,000-foot station on the road, on a line perpendicular to the road. The average was used as a bearing power at each station and plotted. The curves show that the compactions meet the specifications of 250 lb. per sq. in. as all tests were well above this minimum. It is evident from a review of one of the curves, which is contained herein, that conditions of the subgrade are reflected in the curve, for where there was an old gravel base and an unyielding subgrade the compaction was high and where the resistivity of the subgrade was lower the compaction begins to fall off.

The last operation was the placing of the seal coat. In this seal coat we used Texaco OA-250 asphalt at the rate of 3/10 gal. per sq. yd., the surface being covered with crushed limestone chips applied at the rate of 1 cu. yd. of material to 120 sq. yds. of surface.

The contractor in no instance was permitted to place the seal coat until some two or three months after the completed surface had weathered, under traffic. We felt that this was advisable so that observation could be made to see if any defects would develop. All work on the project was completed and it was finally accepted early this spring.

Conclusion

We believe a road surface has been built that not only has proven to be cheaper than gravel, but gives a pleasing appearance, smooth riding surface and one that will last for years to come with a minimum of maintenance. From our experience we would draw the following conclusions:

1. Engineering ingenuity and laboratory control are all-important in the design and control of this type of construction.

2. Selection of materials to be employed requires considerably more than visual inspection.

3. Using a material having larger particles than is usually found in sand dunes is often worth the additional cost, for by the incorporation of this large size aggregate with sand or sandy loam, less asphalt will be required to get the maximum stability.

4. The engineer should use the same care in designing this type of surface as he uses in designing the higher types.

5. Care should be given and money spent to insure a firm, stable subgrade. This surface will not bridge defective spots in the subgrade, but will follow all irregularities therein.

6. There is no standard grading specification for aggregate that can be evolved that will insure success. In our studies we found that many sections of soil-mixed surfaces in several states have shown that every combination of aggregate sizes has been used to make successful roads, and in other sections the same range in grading of aggregate and same proportions have proved to be failures.

7. The belief that maximum density is essential for a good pavement mixture is a fallacy. Many successful mixtures have had less than maximum density.

8. Hardness of the aggregate has been proven to be unessential to successful bituminous pavement mixtures.

9. Hard asphalt is not always necessary to secure stability.

10. Our experience substantiated the conclusion drawn by the California Division of Highways, and set out in the paper by Mr. F. M. Hveem, Senior Physical Test Engineer, delivered at the A. R. B. A. Convention of 1939, in which he says that the ability of a pavement to remain smooth, and resist the destructive effects of traffic is dependent on four independent variable properties.

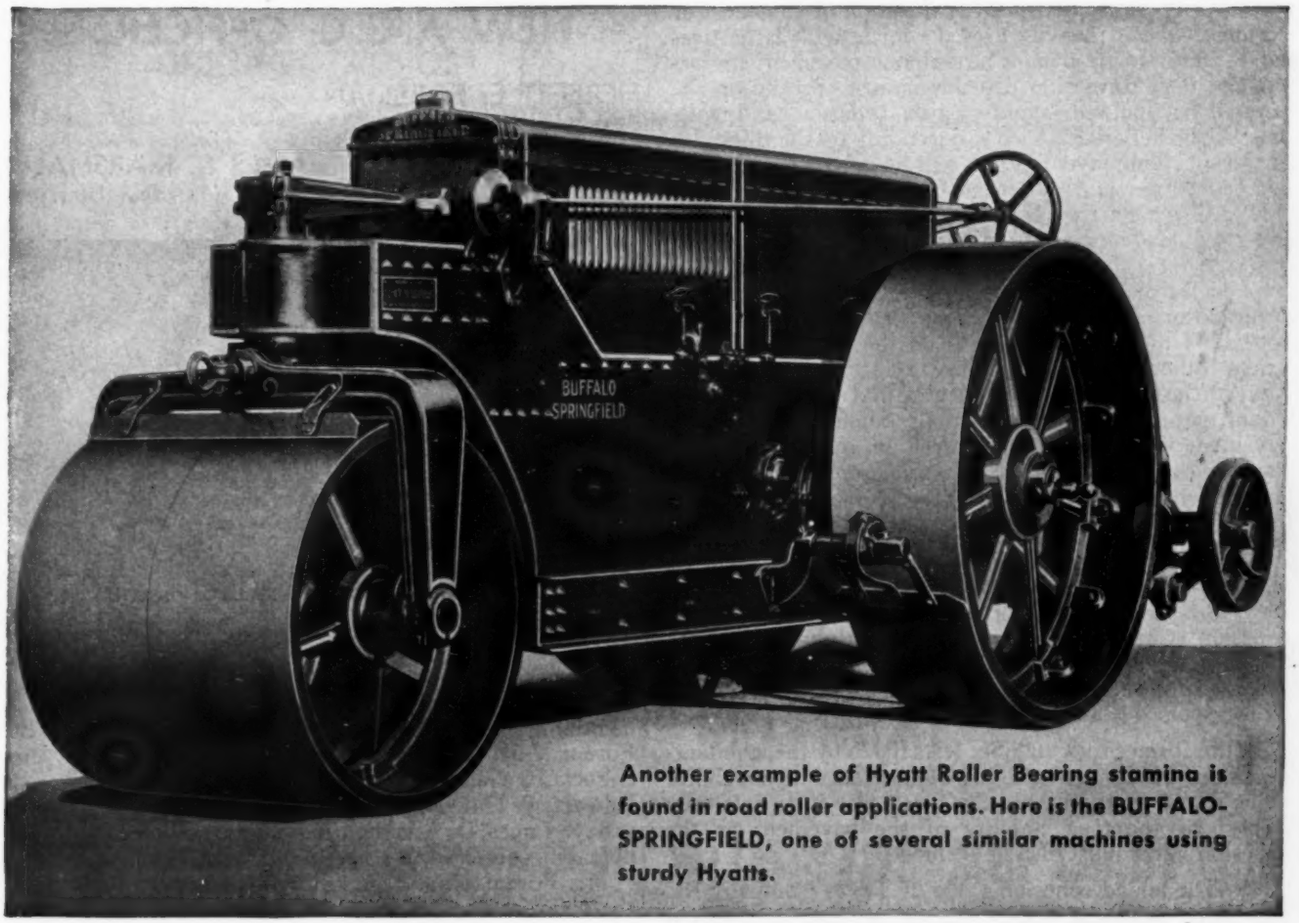
(a) Internal friction, or more accurately called sliding resistance, between the particles of the mineral aggregate.

(b) A property which may be described as cohesion, tensile strength, or in the case of bituminous pavement liquid friction, which varies according to the amount and character of the bituminous binder present and is affected by the density of the mix, the amount and type of filler, and varies with the temperature.

(c) Inertia, which depends on the mass of the pavement.

(d) The angle of shear, which produces a variable effect when the ratio of depth to the diameter of the loaded area is less than one.

These factors respond differently to the area of the



Another example of Hyatt Roller Bearing stamina is found in road roller applications. Here is the BUFFALO-SPRINGFIELD, one of several similar machines using sturdy Hyatts.

Where Only the Fit Survive

HYATTS ARE USED when the going is tough...wherever friction, wear, and replacements must be avoided. With Hyatt Roller Bearings come *staying power* that prolongs machine life . . . *precision* that promotes better performance . . . *design* that guarantees greater mechanical efficiency.

Therefore, operating equipment of every kind is today more dependable and longer lived, because Hyatts help keep it fit for action. Hyatt Bearings Division, General Motors Sales Corporation, Harrison, New Jersey; Chicago, Pittsburgh, Detroit and San Francisco.

HYATT

ROLLER BEARINGS

QUIET

applied load and to the speed or duration of contact. For example, when a heavily loaded vehicle with large tires moves very slowly over a bituminous pavement the resistance to deformation depends almost entirely on the internal friction, only slightly on the cohesion; and while the effect will definitely vary, depending on the thickness of the surfacing layer, results will be only slightly modified due to inertia of the mass. On the other hand, when a loaded vehicle travels at a high speed the distorting effect will also be resisted by the internal friction; but in this case the cohesion between the particles and the inertia of the mass are increasingly important in resisting deformation. The chief value of slab inertia, it would appear, is to reduce the stress on the subgrade, which would otherwise result from rapidly moving loads. Nevertheless, for all types of traffic and for service over a long period of time, the actual stability value of the pavement will depend on the friction and cohesion. As stated above, friction is the only property which operates equally to resist both slow and rapid moving loads, and is little affected by time, speed of traffic, or temperature.

Oil mixed types of surfaces using a low per cent of slow curing road oils must depend practically entirely on friction between the particles for their stability, as the cohesion is usually very low. A sheet asphalt pavement on the other hand using a relatively large amount of hard asphalt forms the type in which the cohesion furnished by the asphalt is an important factor.

In the former case stability tests made by the stabilometer show values representing almost the entire stability value of the mix, while in the latter case it reports only a part of the true stability of the pavement as the cohesion value must also be included.

11. The added cohesion value of Texas Company RC Surfacing Material No. 3, due to the fact that it is a harder asphalt, the penetration varying from 70 to 110 as against the penetration of 150 to 200 under Texas state highway specifications, explains our selection of the first named material, and the comparative stability tests on material bear out our conclusions.

1. The amount of bitumen should be all you can get in the mixture without over lubrication and loss of stability.

13. Actual making of test samples using the material economically located to the job and testing these samples in the laboratory is the best assurance we can give for a successful job.

Fig. 7.—Portable Laboratory Field Equipment for Making Test for Volatiles in Mixture

NEW A. G. C. OFFICERS

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Managing Director, A.G.C.

JAMES D. MARSHALL
Assistant Director

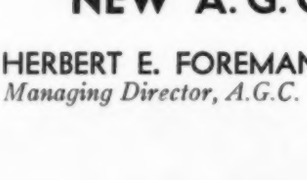

Photo by Harris & Ewing, Washington, D. C.

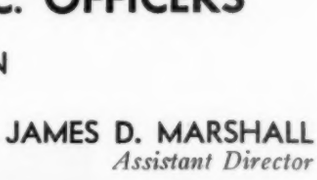

Photo by Underwood & Underwood, Washington, D. C.

President H. B. Zachry announced today that by unanimous vote of the executive committee Herbert E. Foreman has been appointed managing director of the Associated General Contractors of America to succeed Edward J. Harding, who died suddenly early last Saturday. James D. Marshall has been appointed assistant managing director to succeed Mr. Foreman.

Mr. Foreman has been assistant managing director of the Association since 1934, and has been a member of the staff since 1929. Mr. Marshall has been manager of the heavy construction and railroad contracting division since 1934 and is secretary of the Labor Relations Committee.

Mr. Zachry said, "By its unanimous action the executive committee gave them a vote of confidence in their ability to carry on the Association's work."

Before his appointment as assistant managing director, Mr. Foreman had been field secretary and assistant engineer of the Association. He is a native of Dayton, Ohio. After his graduation from Ohio State University in 1919 with a degree of Bachelor of Civil Engineering, he taught for a year at the university.

He held various engineering positions in connection with construction work in Illinois, Indiana, Ohio, and Pennsylvania before becoming a resident engineer for the Ohio State Highway Department. He was successively traffic engineer, executive secretary and assistant to the director of the Department, at Columbus. He received his Bachelor of Law degree in 1928 from Franklin University. He is a member of the Ohio State Bar Association and the Columbus Bar Association.

Mr. Marshall was manager of the Associated General Contractors of Minnesota, Minneapolis, for eight years before coming to Washington. Previously he had been associated with the Northwestern Electric Equipment Co., St. Paul, and had served as vice-president or president of subsidiary companies.

He is a native of Red Lake Falls, Minnesota, and attended the University of Minnesota. He has been president of the Minnesota Electrical Contractors Association, chairman of the Minnesota Section, American Institute of Electrical Engineers, and member of the governing board of the Minnesota Federation of Architectural and Engineering Societies.

14 CROSSING GATES INSTALLED NEAR CHICAGO AIRPORT

Removal of the Chicago and Western Indiana Ry. tracks from a location which cut directly across the Chicago Municipal Airport to a new location parallel to the Indiana Harbor Belt Ry. north of the landing field eliminated a hazard to air planes but threatened new dangers at street crossings. To safeguard these, automatic gates are being installed—14 gates in all—on six streets. Laramie Ave., Lockwood Ave., Long St., Central Ave., and West 55th St. will have two gates each; while Cicero Ave., because of its greater width, will have four.

The gates, and all operating and control equipment, are furnished by Western Railroad Supply Co., of Chicago, and are of the type designated Model 10. All are operated automatically by approaching trains or locomotives; but the gates at Cicero Ave. (the heavily traveled Illinois Route 50) are also subject to manual control by the railroad tower man, to save needless stopping of traffic when cars or engines may be merely standing on the tracks. There are said to be approximately one hundred trains daily over the two railroads at this point.

From a total of 731 installations of this type throughout the country, no accident has ever been reported.

NATIONAL ASPHALT CONFERENCE IN DECEMBER, WITH "DEFENSE" AS ITS KEY NOTE

December 9, 10, 11, 12 and 13 are the dates for this year's National Asphalt Conference. The meeting place is Dallas, Texas, and headquarters will be at the Adolphus Hotel.

The Asphalt Institute, United States Public Roads Administration, State Highway Department of Texas, Highway Research Board of the National Research Council, and Association of Asphalt Paving Technologists are cooperating in a program devoted to the practical uses of asphalt in highway and airport construction to meet national defense needs.

A committee of representatives of these organizations, has prepared a program in which the foremost engineers and technologists of the Public Roads Administration, the National Research Council, the Corps of U. S. Army Engineers, the Civil Aeronautics Board, the State Highway Departments, the Work Projects Administration, City Engineers, Railroad Engineers and Industry representatives from the United States and Canada will present the best current thought on the subject and seek the development of all possible improvements.

Featured subjects will include: Highways and Airports for National Defense, Reinforcing and Widening Existing Highways, Elimination of Bottle-Necks, Highway Principles Applicable to Airports, Asphalt for Erosion Control, and Railroad Ballast and Asphalt Pavement Thickness with Reference to Sub-grade Support.

It is estimated that several thousand engineers, technologists, contractors, public officials and representatives of industry will attend. The sessions are open and all interested are invited to attend.

"GET THERE *fustest*" WITH "THE MOSTA OF THE BESTA" . . . . .

In that heading we give you the combined wisdom and experience of Nathan Bedford Forrest, the old Confederate raider, and Ben Bernie, the famous orchestra leader. Applied to the business of keeping highways clear of snow it means Keep the cuts open with plenty of

AMERICAN SNOW PLOWS.

AMERICAN Snow Plows are designed to give perfect trouble-free service. By utilizing the latest technique of electric welding we give our plows maximum strength with remarkable lightness.

Use your trucks to push snow instead of a lot of excess weight in the shape of poorly designed snow plows. Write for catalog SNP-5 and let us tell you all about AMERICAN Snow Plows.

for Safety STANDARDIZE ON THE Genuine CROSBY CLIP

PERFECT GRIP . . . DROP FORGED STEEL . . . NOT GALVANIZED

DEALERS WITH STOCK IN ALL PRINCIPAL CITIES

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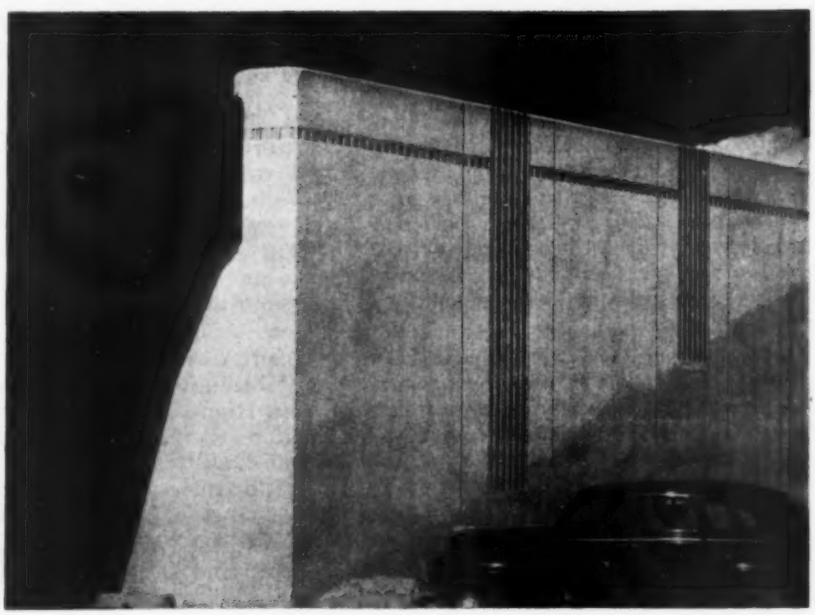
FACE FORMS UNNECESSARY WITH PRECAST CONCRETE SLABS

For Bridge Abutments, Concrete Bridges, Retaining Walls, Grade Separations, and Viaducts

PORTLAND cement concrete has within the last forty years become an indispensable material of engineering construction because of its strength, durability and versatility. During that time it has been used for many concrete structures to make units simulating cut-stone. In comparatively recent years its decorative and plastic qualities gave rise to many buildings and bridges of architectural concrete, a combination of the structural and artistic value of concrete in monolithic form.

Within the last four years the value of concrete in the form of thin slabs (2 inches thick) of large area in varied shapes has become a recognized structural and decorative medium for highway bridges, abutments, and buildings both monumental and commercial. Their natural descriptive name is "Architectural Concrete Slabs."

At Right: One End of the Wheeler's Farm Road Bridge on Wilbur Cross Parkway, Milford, Connecticut. Note striking effect of the black coping on wall



At Right: Wing Wall on the Housatonic Junction Bridge on Wilbur Cross Parkway, Milford, Connecticut. The dark, unfinished portion will be covered by embankment

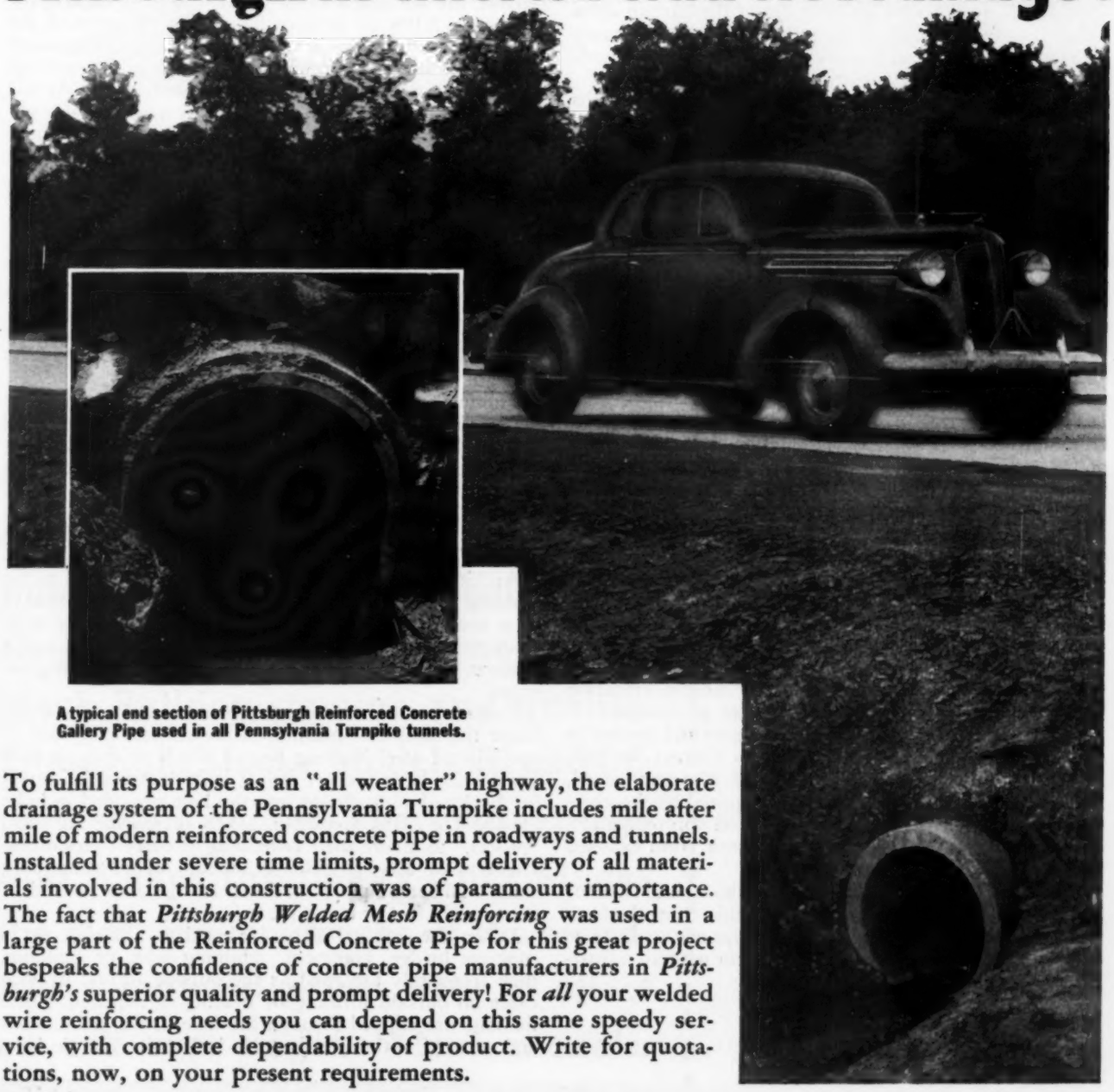
The use of Mo-Sai architectural concrete slabs as the only outer form and at the same time the complete finish to several grade separation bridges of concrete in the states of Connecticut and New York indicates the value which is placed upon this practical and beautiful structural medium.

Structurally they are diaphragms of dense strong concrete, reinforced with heavy, welded, galvanized steel fabric. Generally each unit is large in area. 100 sq. ft. in one slab is quite common and slabs of 150 to 175 sq. ft. have been suc-

Pennsylvania's *"All-weather"* Turnpike

DEPENDS ON

Pittsburgh Re-inforced Concrete Drainage!



A typical end section of Pittsburgh Reinforced Concrete Gallery Pipe used in all Pennsylvania Turnpike tunnels.

To fulfill its purpose as an "all weather" highway, the elaborate drainage system of the Pennsylvania Turnpike includes mile after mile of modern reinforced concrete pipe in roadways and tunnels. Installed under severe time limits, prompt delivery of all materials involved in this construction was of paramount importance. The fact that *Pittsburgh Welded Mesh Reinforcing* was used in a large part of the Reinforced Concrete Pipe for this great project bespeaks the confidence of concrete pipe manufacturers in *Pittsburgh's* superior quality and prompt delivery! For *all* your welded wire reinforcing needs you can depend on this same speedy service, with complete dependability of product. Write for quotations, now, on your present requirements.

PITTSBURGH STEEL COMPANY
1661 GRANT BUILDING PITTSBURGH, PA.

Pittsburgh CONCRETE PIPE Reinforcing

cessfully made and erected. They weigh 25 lb. per sq. ft.; thus a slab of 100 sq. ft. will weigh 2,500 lb., comparatively light considering the large area. Projecting from the back of the slabs, securely attached to the reinforcing within, are located galvanized strap and loop anchors for securing them to the structural concrete or back-up masonry.

Design

Designing in this new material draws the curtain upon a new freedom. Dignity, large scale character and beauty go together. Color and texture can be freely employed. Strength and durability is inherent.

The compressive strength of the concrete in the slabs at 28 days is uniformly more than 7,500 lb. per sq. in. Absorption is uniformly less than 6 per cent. All of the ingredients entering into the fabrication of thin Mo-Sai architectural concrete slabs are tested in a laboratory for durability and suitability. In addition the facing aggregates are selected for color and appearance. Proven granites, quartzes and vitreous procelain bodies are crushed, sized and carefully recombined with cement, water and color to produce a concrete body with the minimum number of voids, and to obtain the finished color and texture desired.

Preparing the Slabs

The manufacture of thin Mo-Sai architectural concrete slabs consists of many consecutive steps. Continuity of the operations at the right time is an important part of the job. The known factors of making a high grade concrete must be religiously employed.

The concrete is placed in the mold in (2) stages, facing and backing, vibrated continuously until the entire mold is filled. The method of vibrating Mo-Sai slabs is a specially developed process. The vibrators are of the very high frequency and low amplitude type. The method produces a concrete of low absorption and high density. The water-cement ratio is low, never more than 4½ gal. of water per sack of cement, yet under Mo-Sai vibration the aggregates are suspended in a paste of cement.

The reinforcing is designed for stresses and strains to which the slabs may be subjected. It is a heavy, welded, galvanized fabric. Stiffening members, also galvanized, are welded to the fabric as may be required by the engineering design. The reinforcing is placed approximately, during the casting operation, 1¼ in. back from exposed face of slab.

Specially designed galvanized anchors and anchor loops are cast into slabs so as to protrude from the back side of the slab. These anchors and loops are so made as to permit tie rods to be fastened to them with an adjustable locking unit, thereby holding the slab in a predetermined position. At least every 4 sq. ft. of slab is provided with an anchor. Unusual conditions may require more.

After casting, the slabs are allowed to remain in the forms or molds from 12 to 24 hrs. or just long enough to attain a degree of strength and hardness to permit them to be removed and placed on to easels in a near vertical position with the outer surface exposed. Immediately thereafter the surface is vigorously brushed to remove the surface film of cement and to expose the aggregate. After all surface film has been removed the entire exposed surface is treated with a grout composed of similar materials as used in the making of the unit and well rubbed in to fill all pin holes and depressions. At this time the units are tested for trueness by means of straight edges, and any tendency to warp and twist is prevented by securely tieing the slabs to a frame work of easels with heavy wire through the anchors and against wedges.

From the time of removal of the slabs from the mold and for at least two weeks thereafter, both the front and the back of the unit is kept continuously damp and not in the least allowed to dry out. The fact that Mo-Sai slabs are only 2 in. thick permits complete uniform curing and hardening throughout their entire thickness. The thorough understanding and the care with which this curing is attended, in a great measure adds to their density, strength and hardness.

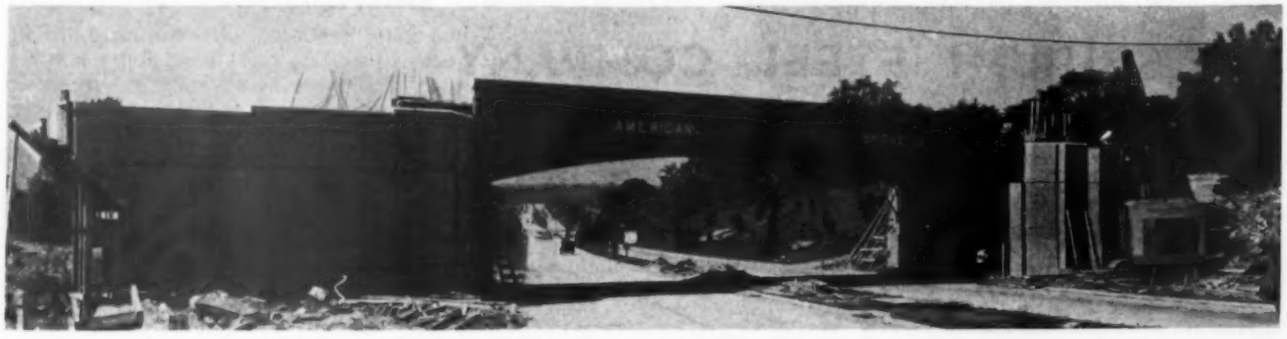
The final operation consists of washing and scrubbing the surface with muriatic acid and water to etch it, removing the excess grout film and exposing the aggregate in its natural color. This operation may be undertaken any time after the slabs are 8 to 10 days old. After the allotted curing time the slabs are allowed to slowly dry out. At 21 days or thereafter the delivery of the units may begin.

Architectural concrete slabs may be transported to the building site on trucks or in open railroad cars, but always in a nearly vertical position secured with heavy wire against a frame work of wood. They are set upon a soft cushion, preferably celotex strips, thereby preserving the edges.

Ordinary stone setting equipment is used to raise and lower the slabs into position in the structure. By aid of special cast steel hoisting blocks which fit into anchors against the back face of slab it is quite simple to insert the hooks of sling chains into the hole provided in hoist blocks. The slabs are set in a bed of mortar and lead "pellets," to insure their remaining at correct elevations. Erection of Mo-Sai Slabs is thought of in terms of a small number of pieces each of a large area instead of many cubic feet or many pieces.

When the finished slabs are used as a facing for a concrete bridge, abutment, retaining wall, or building, they frequently are used as the outside forms. In such cases no outside forming or bracing is required. Form tie-bolts are slipped through the hole in the slab anchor and secured with an adjustable lock unit. The tie bolts

Below: Clinton Avenue Bridge Over Merritt Parkway in Westport, Connecticut, Nearing Completion



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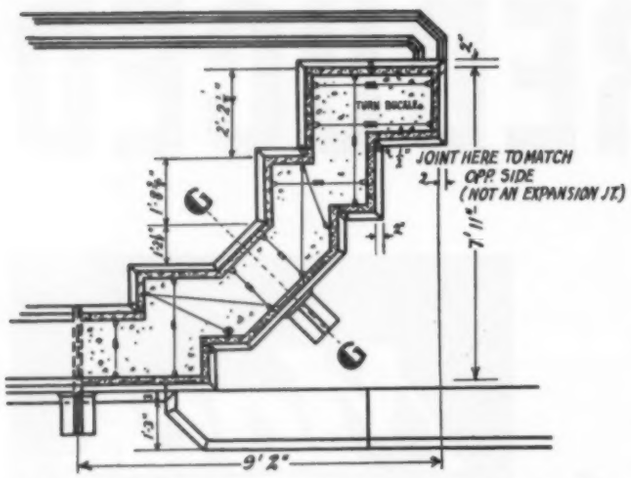
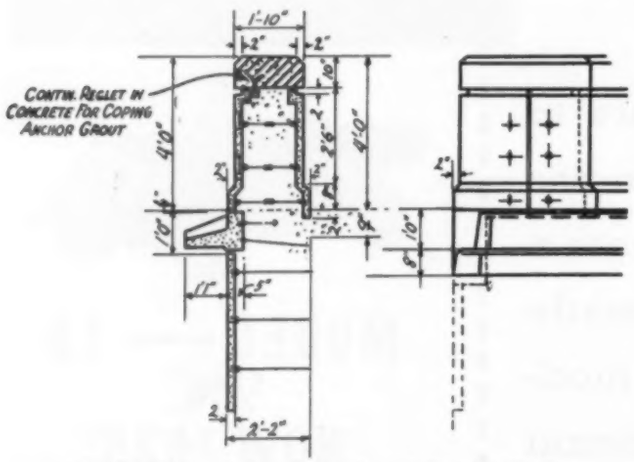


Horizontal Half Section Through Parapet Wall of Southwest Pylon, Clinton Avenue Bridge, Merritt Parkway, Connecticut



Section G-G and Part Elevation of Parapet Wall

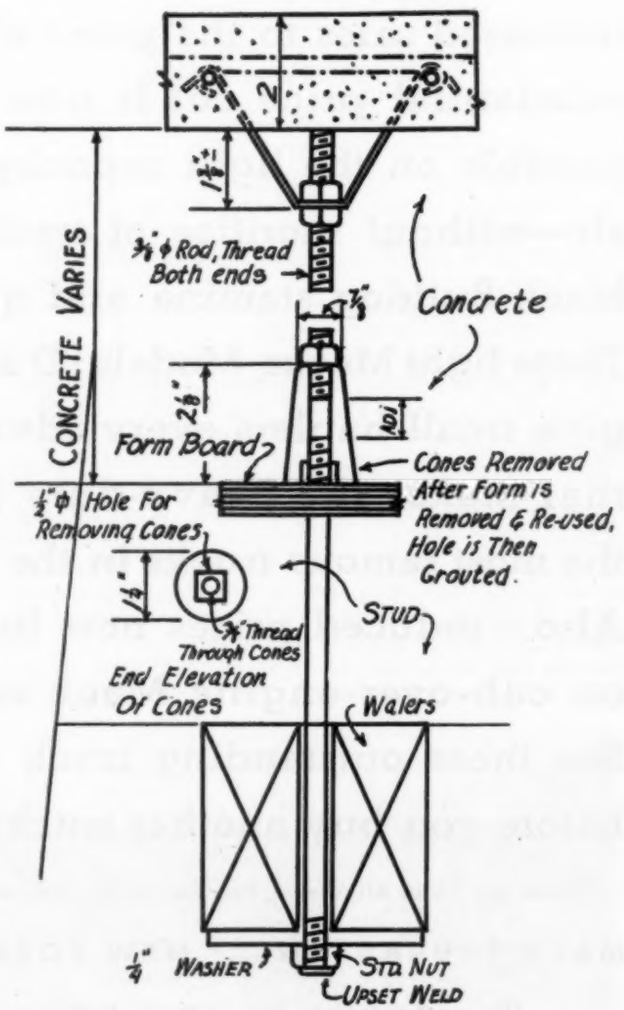
are then attached to the rear forms in the customary manner. Occasionally at the joints in Mo-Sai slabs and especially where four corners meet, a tie bolt is run through the joint to the outside surface and a 4 in. by 4 in. by ¼ in. galvanized plate is slipped on and brought up with a unit so that adjoining edges and surfaces of slabs can be perfectly aligned. Thus it is simple to inspect the exposed surface and alignment of slabs and to correct any defect before concrete is placed between the slabs and the back form. After the structural concrete is placed, hardened and the back forms removed, the Mo-Sai slabs become the finished surface of the structure except for the customary cleaning down and "pointing up" as is usually done with any masonry faced buildings. It is recommended that the pointing be done with a mastic compound furnished by the manufacturer of the slabs.

Uses of Slabs

An interesting use of architectural slabs is as a facing for structural concrete in highway bridges, retaining walls, grade separations, and viaducts. The first thought in work of this kind is utility, durability and performance of a definite service. Besides this, we have also learned to enjoy beauty not only in design but also in surface texture. All of this is accomplished by the use of architectural concrete slabs as the outer form. Batters, re-entrant angles, arches, large returns, low relief ornament, etc., are easily formed. In cases where required for highway safety, reflective aggregates can be employed in sunk panels or letters. In appearance the slabs resemble massive dignified units, thereby adding to the character of a highway bridge. Existing today are some very fine examples of this class of work, such as the several grade separation bridges on Connecticut's Merritt Parkway.

Although one is apt to think of these slabs in connection with structural concrete there are many interesting examples of their use as a facing to masonry constructed buildings both new and old. In new work the anchors are laid into the wall as the work progresses. In modernization work it is generally not necessary to cut away any of the old masonry because of the thinness of the slabs, which is an economy. In these cases special anchors are rigidly attached to slabs at the time of manufacture. Opposite these anchors, pockets are cut into masonry and filled with a stiff cement grout thus engaging the anchors and forming a pad of hardened grout which holds the slab in exact position.

The advantages described may be fairly expected to result from this type of construction. Whether they will materialize or not depends upon the skill of the men who make them. Specifications have been prepared for gradation of aggregates, manipulation and the sequence of construction operations. The process is not patented but it is desirable to confer with the Dextone Company of New Haven, Connecticut or the Universal Atlas Cement Company of New York before attempting to utilize the method.



Plan Showing Typical Anchors

Mark this SOIL STABILIZATION article a "must"

A feature article in this issue of "Roads and Streets" describes one of the most important of recent SOIL STABILIZATION projects, located in Fort Bend County, Texas.

The article is ably written by the Consulting Engineers on the project, Haile and McClendon, Houston, Texas.

The increasing importance of SOIL STABILIZATION in modern highway building makes the reading of this article a "must" for every engineer and contractor.

The Fort Bend County project is another instance of the excellent results obtainable in SOIL STABILIZATION work with TEXACO Asphaltic products. Approximately 1,500,000 gallons of a Rapid-curing TEXACO Cutback Asphalt were used in this important project.

An outstanding Soil Stabilization project in Fort Bend County, Texas, which called for 1,500,000 gallons of TEXACO Cutback Asphalt.

TEXACO ASPHALT

THE TEXAS COMPANY, Asphalt Sales Department, 135 E. 42nd St., New York City
Chicago Boston Philadelphia Richmond Jacksonville Kansas City Houston

MICHIGAN TEST ROAD

Seventeen Miles of Concrete Construction To Determine Fundamental Principles

IN MAY, 1940, Murray D. Van Wagoner, Michigan State Highway Commissioner, realizing the need of a comprehensive evaluation of modern theories of design and construction practice, let contracts for the construction of a 17.6-mile, 22-foot concrete test road to be built on route M-115 between Farwell and M-66. The completion date for the project is November 1, 1940.

The test embodies the latest ideas of concrete road construction, and is considered to be one of the most outstanding projects of its kind since the Bates road test in Illinois in 1922-1923. The primary purpose of the project is to establish certain fundamental principles in concrete pavement design, and to correlate laboratory studies with construction methods in order to develop more durable concrete pavement.

Subjects To Be Studied

A ten-mile section of the test road is devoted to the study of such factors in design as spacing of expansion and contraction joints, uniform thickness cross section versus thickened edge cross section, amount of reinforcing steel necessary, relation of cross section to subgrade supporting value, cross section thickness and the prestressing of concrete slabs during curing. Construction factors incidental to this particular test section are the mechanical handling of concrete, mechanical tamping of forms, vibration of concrete at joints, and the use of several different types of joint seals.

The remaining 7.6 miles of the test road is devoted to a durability study of concrete. In this section the constituents which affect durability have been varied to include such factors as, the grading of the aggregate, design of the concrete mixture, change in physical and chemical characteristics of concrete as influenced by the addition of various types of admixtures with the portland cement, the use of various finishing methods, and the application of different methods of curing.

Tests To Be Made

Throughout the entire project special measuring devices will be installed, such as electric strain gages for measuring stresses, thermocouples, moisture cells for determining moisture content at different positions, both in the slab and subgrade, permanent monuments for detecting slab movement, and elevation points for determining the vertical displacement of the slab at expansion joints. The durability section will be subjected to calcium chloride treatments to determine the relative ability of the various concrete mixtures to resist scaling and disintegration. This study will be augmented by extensive laboratory work.

A meteorological station was established from which a complete record of local weather conditions will be obtained for the duration of the study.

It is estimated that four to five years will be required to make a complete study of all of the factors, but periodic reports will be made as the work progresses.

The contractors on this project are W. L. Thon Company, Inc., of Wyandotte, Michigan, and the Bridgeport Core Sand Company, of Saginaw, Michigan. The Thon Company are constructing the design section, and the durability section is being constructed by the Bridgeport Core Sand Company.

The supervision of the construction of the test road by the Michigan State Highway Department is under the direction of Mr. H. J. Brighton, project engineer, representing the Construction Division, and Mr. G. A. Mansfield, associate engineer, of the Research Division.

The research phase of the test road is under the jurisdiction of the Research Division, a new division incorporated into the Michigan State Highway Department in September, 1939, to carry on more effectively the research work previously done by the various divisions and to investigate the specific technical problems arising within the Highway Department.

Other Research Projects

In addition to the test road studies, the Research Division is studying primary problems pertaining to higher quality concrete and bituminous pavements, as well as subgrade investigations and soils stabilization. In regard to concrete pavements, special emphasis is being placed upon such subjects as, scaling, curing, joint design and concrete mix design. The changes in characteristics of binding medium and consequent development of specifications for binding material are being considered in connection with bituminous pavements. Subgrade and soil studies involve measurement of subgrade modulus, the relation of characteristics of subgrade soil to supporting value, and various methods of soil stabilization.

The offices and laboratory of the Research Division are located in Olds Hall of Engineering, Michigan State College, East Lansing. The regular equipment of the Civil Engineering laboratory, which is used jointly by the College and the Research Division, has been augmented by special equipment necessary to conduct advanced studies in Highway Research work.

The personnel of the Division, consisting of several specialists in the field of highway research, and supplemented by graduate students majoring in pertinent problems, is under the direction of J. W. Kushing, Research Engineer, and E. A. Finney, Assistant Research Engineer.

You know
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SOIL-CEMENT ROADS
Laboratory technique assures results

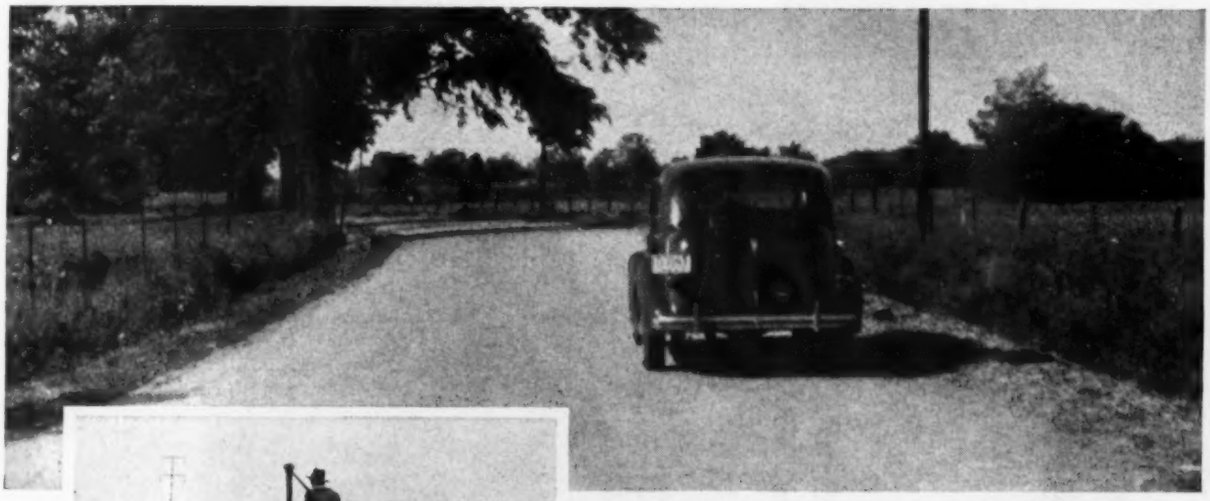
THERE is no guesswork in the design of mixes and construction of weather-resistant, durable, low cost roads of soil-cement.

Intensive laboratory research has developed means for accurately predetermining the cement, moisture and density required for a given roadway soil—to insure durability under wetting-drying and freezing-thawing conditions encountered in the field. These laboratory findings must be applied to every job through careful engineering control. Both laboratory and construction procedures are scientific yet *simple in application* under competent engineering supervision. Only simple equipment is required.

Sure Results from Simple Tested Methods

Experience in 156 jobs throughout the country totaling 348 miles (completed to January 1, 1940) has substantiated the economy and durability of soil-cement. We invite you to look into this service record and learn more about the simple laboratory tests which assure good results with your soils.

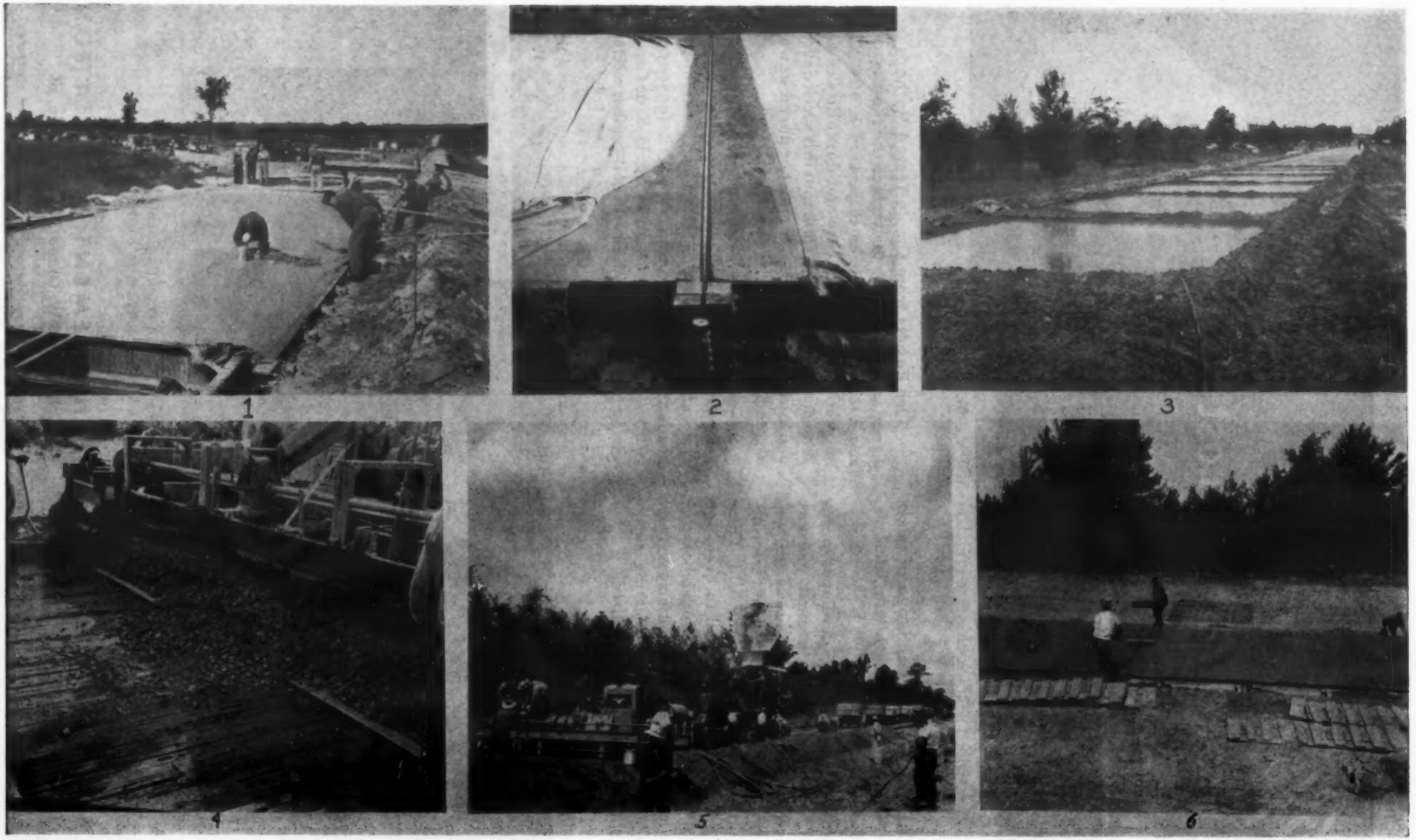
Soil-cement roads are not intended to replace portland cement concrete for the heavy-duty service where concrete is essential. But soil-cement is ideal for light-traffic roads, streets and airport runways. Write for your copy of *"Soil-Cement Roads"* (free in the U. S. or Canada) giving procedures for the use of soil-cement mixtures.



Soil-cement road in Franklin County, Ohio.
(*At left*) Mixing cement with roadway soil.

PORTLAND CEMENT ASSOCIATION
Dept. 11-28, 33 W. Grand Ave., Chicago, Ill.

A national organization to improve and extend the uses of concrete . . . through scientific research and engineering field work



Scenes on Construction of Michigan Test Road

1—*Sampling Concrete on Sections Containing Admixtures*

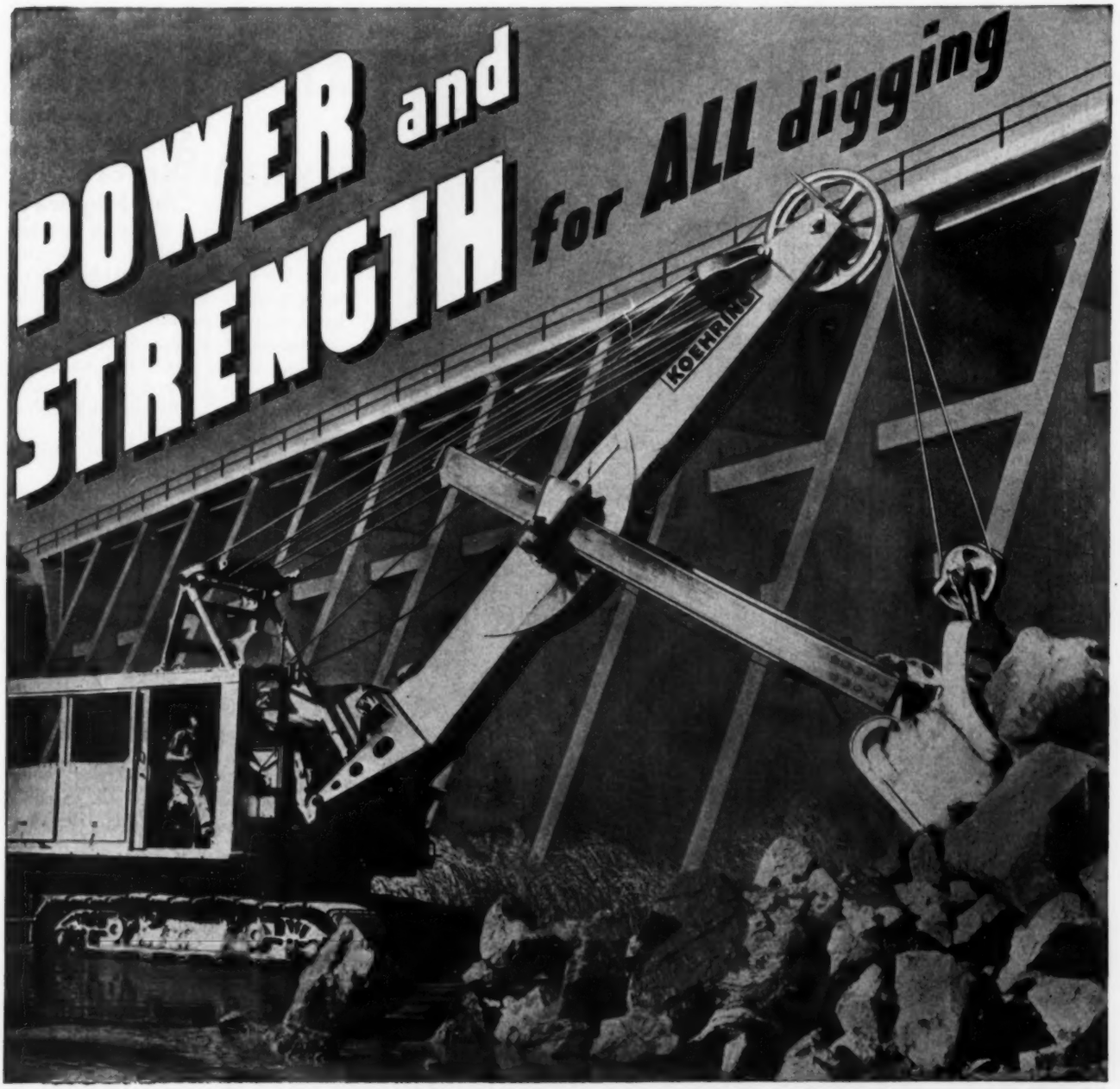
2—*Installation of Pressure Cell on Stress Curing Section*

3—*A Study of Various Curing Methods for Resistance to Materials Used for Ice Control*

4—*Twenty-two Foot Mechanical Concrete Spreader (First of Its Kind)*

5—*Most Modern Type of Contractors Equipment Used on Test Road*

6—*Brooming Concrete Prior to Bituminous Curing to Determine Effectiveness to Ice Control*



KOEHRING POWER — built into the shovel from engine to clutches, gears, and crowd—power that flows without loss or interruption to the digging dipper — is the "stuff" that counts to maintain high speed maximum production on day and night working schedules.

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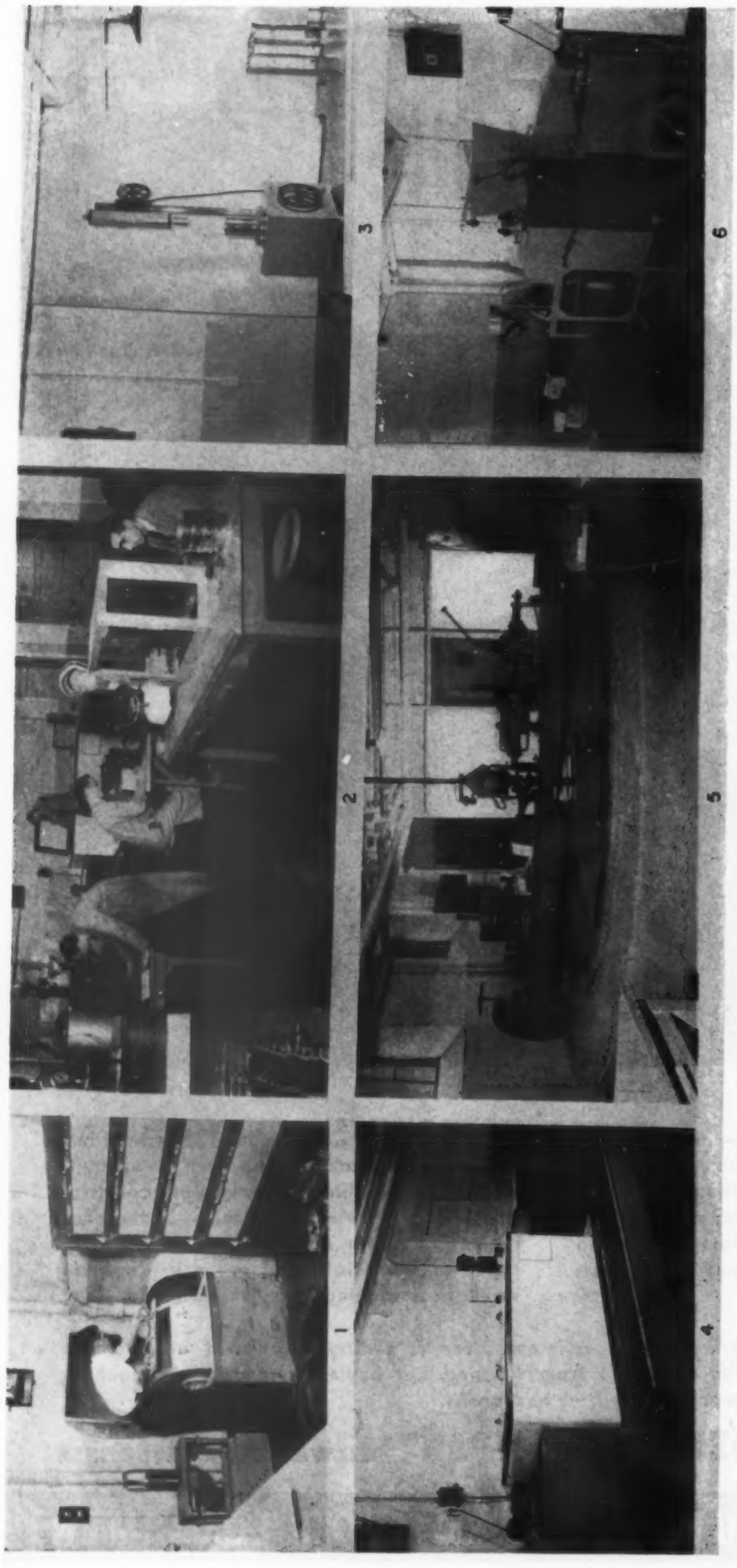

Highway Research Laboratory at East Lansing, Michigan

1—*Vibratory Soil Compaction Apparatus, Deval Abrasion Machine and Drying Oven*

2—*General View of Cement and Concrete Laboratory*

3—*Electrically Operated Proctor Compaction Machine*

4—*Freezing Cabinet and Thawing Tank Used in Concrete Durability Study*

5—*Continuous Operating Treadometer Used in Present Gravel Stabilization Project*

6—*Circular Saw Used in Cutting Concrete Specimens for Microscopic Studies*

R. S. Beightler Becomes Major-General; H. G. Sours Succeeds as Director of Ohio Highways

Early in October Robert S. Beightler, Director of Highways for the State of Ohio, was appointed Major-General in command of the 37th Division, Ohio National Guard, now training at Shelby, Mississippi.

Robert S. Beightler

Hal G. Sours, who has been Assistant Director and Chief Engineer of the Ohio State Highway Department since January, 1939, and prior to that was Engineer of Summit County, succeeds as Acting Director. Mr. Sours, is also Pres. of the A. R. B. A.

Hal G. Sours

Congratulations to General Beightler and Mr. Sours are extended by their great number of friends in the highway field.

First Step completed

in Pittsburgh's Golden Triangle Belt Highway

INSTEAD of resorting to the usual expedient of street-widening for traffic relief, the reconstruction of Water Street employs the sound engineering principle of traffic segregation on paralleling roadways.

The old Water Street surface pavement was retained for local westbound travel, but local eastbound traffic is diverted to a new viaduct skirting the Monongahela River. Between the two, and abutting, a third and new depressed roadway provides for two-way vehicular travel without local traffic interference.

Unusually interesting is the 2,300-foot steel superstructure of the river-front viaduct. This was designed to resist uplift from floods, and involved horizontal and vertical curves, grade, and warped surfaces at street connections which overpass the depressed central roadway.

Main carrying members, of pleasing appearance, are cantilever and suspended deck girder units with curved bottom flanges. A steel-framed floor system supports a 30-foot roadway of concrete-filled I-Beam-Lok and an 8-foot reinforced concrete-slab sidewalk.

American Bridge Company not only fabricated and erected all structural steel but also contracted for the finished concrete roadways, including concrete traffic islands, curbs and fascias.

Welding *Carnegie-Illinois Steel Corporation 4¼-inch I-Beam-Lok steel roadway decking, later filled in with concrete. Steel framing (at the right) supports a reinforced concrete sidewalk slab 8 feet wide. Universal Atlas Cement Company's cement, a portion of which was "Atlas High Early," was used for the roadway concrete.*

The Water Street project was built for the County of Allegheny—John F. Laboon, Director, County Department of Works.

River-front view *of the 3-lane eastbound-traffic viaduct extending from the Smithfield Street Bridge to West Street, and underpassing the Wabash Cantilever Bridge over the Monongahela River, which was erected by American Bridge Company in 1904. Two lines of viaduct girders, spread 35¼ feet on centers, are supported on concrete portal-type bents, spaced, in general, 54 feet apart.*

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UNITED STATES STEEL

LABORATORY TESTING TERMS

A Glossary of Material Testing Terms and Methods of Test

By D. G. RUNNER,* Mem. A.S.T.M.
Washington, D. C

(Continued from page 72 of ROADS & STREETS *for October. For introductory statement, see page 70 of that issue)*

Gage Points—Short pieces of stainless steel, glass rods, capillary tubes, or similar devices placed in mortar or concrete specimens and used in determining the volume change of the mortar or concrete.

Gamma Dicalcium Silicate—A modification of di-calcium silicate that may form in clinkers of certain compositions or following certain heat treatments, which is responsible for dusting of clinker. Has little hydraulic value.

Gas-House Coal Tar—Coal tar produced in gas-house retorts in the manufacture of illuminating gas from bituminous coal.

Gillmore Needles—Apparatus used to determine the time of set of cement, and consisting of two needles, one weighing ¼ lb. (for initial set) and the other 1 lb. (for final set). (Fig. 2.)

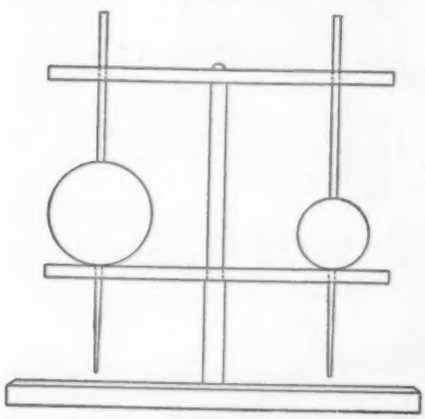

Fig. 2—Gillmore Needles

Glacial Gravel — Rock material transported by a glacier and deposited by or from the ice or by or in water derived from the melting of the ice.

Gneiss — A medium or coarse-grained crystalline rock possessing some form of parallel structure due either to the uniform orientation of certain tabular or prismatic minerals, or to the presence of wavy discontinuous surfaces indicating a lenticular structure, or of bands of varying mineralogical composition which retain their continuity and parallelism throughout a considerable mass of rock. (Fig. 3.)

*Author Geology for Civil Engineers; Co-author with V. J. Brown of Engineering Terminology.

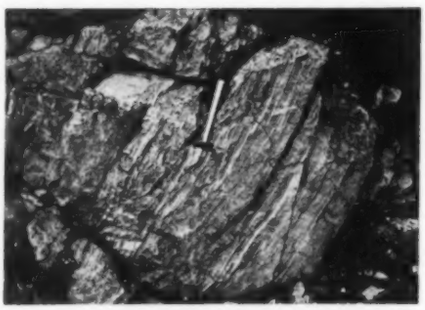

Fig. 3—Veined Gneiss, Opdal Norway
Photo Courtesy Dr. Tom F. W. Barth

Grab Set (Of Cement)—A cement which rapidly develops a crust sufficient to indicate an initial set but which is not hardened in the interior and on reworking may set normally.

Gram—A metric unit of weight equal to 0.0022 lb.

Granite—A granular igneous rock composed essentially of quartz, orthoclase or microcline, and mica. Commonly a part of the feldspar is plagioclase. The mica may be either biotite or muscovite or both. Hornblende is a common, and augite an uncommon, component. Apatite, zircon, and magnetite are also usually present.

Gravel—The coarse, granular material, resulting from the natural erosion of rock; and which is retained on a number 4 sieve.

Heat of Hydration—Refers to the heat evolved during any given time period folowing the mixing of cement with water.

Heat of Solution — The heat evolved when a material is dissolved in any specified solution.

Hydration—A combination of a compound with water to form a hydrate.

Hydrated Lime—A dry powder obtained by treating quicklime with water enough to satisfy its chemical affinity under the conditions of its hydration. It consists essentially of calcium hydroxide or a mixture of calcium hydroxide and magneium oxide and magnesium hydroxide.

Hydraulic Cement—Cement which sets under water. The rock which on being calcined and ground very fine yield this type of cement and should contain in addition to lime certain proportions of alumina, silica and magnesia. A little iron is also present.

Hygrometer — Any properly calibrated instrument which indicates directly, or indirectly, the humidity of the air.

Hydrolysis—The interaction of a compound with water as a result of which the compound is broken down into basic or acidic constituents or both. In cement chemistry this refers principally to the interaction of C_3S with water which results in the formation of calcium hydroxide and a less basic calcium silicate hydrate.

Hydrometer—A float of which the depth of immersion indicates the specific gravity of a liquid.

Igneous Rocks—Rocks formed by solidification from molten magma, and are commonly divided into two great classes, namely: plutonic and volcanic. Some examples are granite, diorite, basalt, etc.

Inert Material—Components of a mixture which have no binding or cementitious properties.

Internal Friction (Of Soils)—Is the resistance to motion caused by the roughness of the surface and the shape and size of the individual particles in the soil; that is, the resistance to motion of the particles over each other.

Kilogram—A metric unit of weight equal to 35.273 ounces or 1,000 grams.

Knapping—The act of breaking rock with hammers or sledges.

Laboratory—A building or a room equipped with suitable standard apparatus for making physical and chemical tests on road-building materials.

Laitance—A thin layer of inert material which collects on the surface of portland cement concrete after being placed.

Lake Asphalt—Refers to native asphalt found in the form of lake deposits such as Bermudez and Trinidad.

Le Chatelier Flask—A specially designed stoppered flask of about 275 ml. capacity and used in determining the specific gravity of cement, sand, and other fine non-bituminous materials. (Fig. 4.)

Ledge Rock—The true bedrock, as distinguished from boulders or rock crushed by artificial means.

Lignite—A brownish-black coal in which the alteration of vegetal material has proceeded further than in peat but not so far as sub-bituminous coal.

A NEW COST DATA BOOK

Outline of Contents

CHAPTER 1. INTRODUCTION—Brief discussions of construction costs, prices, profits and the uses of cost data.
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CHAPTER 4. ENGINEERING—Data from states, cities and other sources on the costs of various kinds of surveys and other engineering. There are brief articles on aerial surveys and seismographic soil and rock surveys.
CHAPTER 5. RIGHT-OF-WAY—A general discussion followed by records of actual experience and costs.
CHAPTER 6. EQUIPMENT—This chapter contains several rental and ownership expense schedules in full detail, followed by articles on operating and maintenance costs, including records of fuels, lubricants, etc., a mathematical analysis of the problems of selecting and retiring machines, and a table of depreciation rates.
CHAPTER 7. LABOR—Schedules of established minimum wage scales and records of wage rates in various states; comparisons of contract work and day labor; convict labor costs and other pertinent matter.
CHAPTER 8. CLEARING AND GRUBBING—Records of clearing with tractor-mounted equipment, hand and horse methods, stump blasting, etc.
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CHAPTER 10. HAULING AND HANDLING MATERIALS—Studies of hauling operations on power shovel jobs, concrete construction and bituminous construction; truck movements at yards; industrial railways; team and wagon hauling; and other articles.
CHAPTER 11. PRODUCTION OF AGGREGATES—Articles on labor requirements and costs of producing sand, gravel and crushed stone at various locations.
CHAPTER 12. UNTREATED BASES AND SURFACES—Waterbound macadam, crushed rock and gravel construction.
CHAPTER 13. STABILIZATION OF BASES AND SURFACES—This chapter is devoted chiefly to work with calcium chloride, articles on portland cement and bituminous stabilization being given in the chapters on concrete and bituminous construction.
CHAPTER 14. BITUMINOUS SURFACES AND BASES—The five parts of this long chapter contain articles on various methods in different states. Part 1, Surface Treatments; Part 2, Bituminous Macadam; Part 3, Mixed-in-Place Construction; Part 4, Traveling Plant Construction; Part 5, Stationary Plant Construction.
CHAPTER 15. CONCRETE SURFACES AND BASES—Contains numerous detailed records of construction. There are articles on work with 27-E pavers, 34-E pavers, tandem set-ups, batching, hauling, curing, joints, cement-bound macadam, soil-cement roads, stabilization, and other subjects.
CHAPTER 16. BRICK PAVEMENTS—Records of brick pavement construction from various cities and states, including an article on vibrated monolithic. Short references to granite block.
CHAPTER 17. SIDEWALKS, CURBS AND GUTTERS—Miscellaneous prices and details of construction.
CHAPTER 18. WALLS, FENCES AND GUARD RAILS—A brief chapter of data on these items of highway construction.
CHAPTER 19. BRIDGES AND CULVERTS—Cost data on a large number of steel, concrete and timber bridges and grade separations—also culverts of various types. There are two articles on pump installations for underpass drainage.
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Road and Street Construction Methods and Costs

BY

HALBERT P. GILLETTE

AND

JOHN C. BLACK

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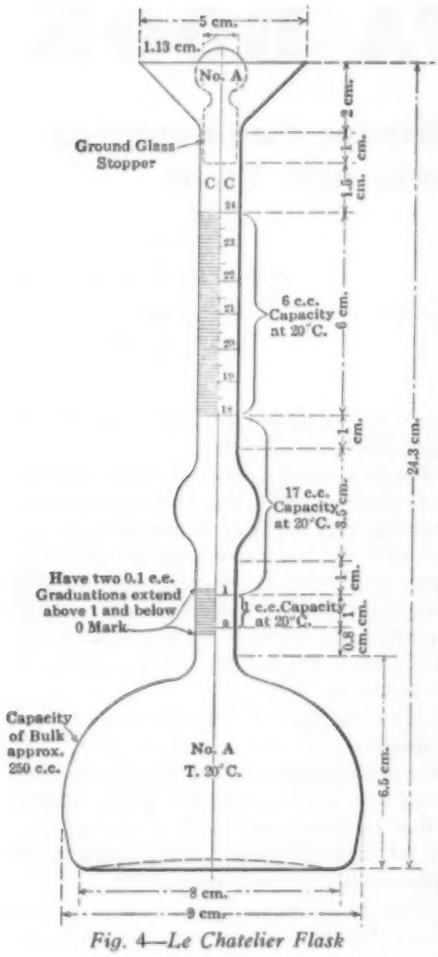

Fig. 4—Le Chatelier Flask

Limestone—Any natural rock of sedimentary origin composed chiefly of calcium carbonate or of calcium and magnesium carbonates in either its original chemical or fragmental or recrystallized form.

Lithological Count (Of Gravel) — A method for determining the percentage composition of gravel. About 150 pieces of gravel are selected, ranging in size from ½ in. to 2 in., and then separated into the various types of material such as granite, diorite, sandstone, quartzite, limestone, etc.

Los Angeles Rattler—A machine for determining the abrasive resistance of coarse aggregate. The machine consists essentially of a cylindrical drum 28 in. in diameter and 20 in. in length mounted longitudinally on a horizontal shaft and having a shelf 3½ in. wide extending from end to end on the inside. 5,000 grams of aggregate and 5,000 grams of round abrasive charge are placed in the machine and revolved for 500 revolutions at 30 to 33 r.p.m.

Magnesium Sulphate — The salt either the anhydrous ($MgSO_4$) or crystalline ($MgSO_4.7\ H_2O$) used in making the magnesium sulphate test for soundness of aggregates.

Marble—Any crystalline or micro-crystalline natural rock deposit of sedimentary origin composed chiefly of calcium carbonate or calcium and magnesium carbonates.

Matrix—The medium that surrounds or unites the constituents of an aggregate. For example, the mortar would be considered the matrix that binds the coarse aggregate in concrete.

Mechanical Analysis (Of Soils) — May be defined as a grading by dry weight of the grain particles obtained by using a combination of sieves down through the number 270 and hydrometers (sedimentation) to 0.001 mm.

Mesh—The square opening of a sieve.

Metamorphic Rocks—Are those which have been changed by temperature, pressure, and chemical fluids into new forms being more stable under the new conditions. Some examples are schists, gneisses, marble, etc.

Micron—A linear unit equal to one-thousandth of one millimeter.

Milliliter—A metric unit of volume equivalent to 0.0393 fluid ounces; 0.001 liter; or 1.000027 cubic centimeter.

Millimeter—A metric unit of length equivalent to 0.0393 in.; 0.001 meter; 0.1 centimeter; or 100 microns.

Mineral Filler—Consists usually of limestone dust, portland cement, or other inert material. Used in sheet asphalt and bituminous concrete pavements.

Mortar—(1) a material used in a plastic state, which can be troweled, and becomes hard in place, to bond units of masonry structures. (2) a mixture of cement with sand and water.

Mortar Sand—Sand for use in mortar usually consists of hard, durable uncoated mineral or rock particles, free from injurious amounts of organic or other deleterious matter, and should pass the number 8 sieve.

Native Asphalt — Asphalt occurring as such in nature.

Normal Temperature — As applied to laboratory observations of the physical characteristic of bituminous materials is 25° C. (77° F.)

Organic Matter Test—This test is made on sand and consists essentially of adding a definite amount of 3 per cent NaOH solution to a definite amount of sand and allowing the mixture to stand for 24 hours. At the end of this time the color of the solution is compared with color charts to determine whether or not injurious substances are present in the aggregate.

Oven-dry—A term commonly applied to aggregates which have been subjected to a temperature of about 100° C. in an electric or gas-fired oven.

Paving Brick—A hard burned vitrified clay unit for use in pavements with physical qualities that will meet the requirements of standard specifications. The sizes average about 3½ in. x 4 in. x 8½ in.

Penetration (Of Bituminous Materials) —Is defined as the consistency of a bituminous material, expressed as the distance that a standard needle vertically penetrates a sample of the material under known conditions of loading, time, and temperature. Where the conditions of test are not specifically mentioned, the load, time, and temperature are understood to be 100 grams, 5 seconds, 25° C. (77° F.) respectively, and the units of penetration to indicate hundredths of a centimeter.

Percolation (In Soils)—The movement of water through soil caused by gravity.

Photoelectric Cell—An electric cell actuated by a source of light. The intensity of the current generated is proportional to the intensity of the beam.

Plasticity Index (Of Soils)—Is usually defined as the liquid limit minus the plastic limit.

Polarized Light—Light vibrating in one plane. Used in connection with study of thin sections of cement and/or rock.

Portland Cement—The product obtained by finely pulverizing clinker produced by calcining to incipient fusion an intimate and properly proportioned mixture of argillaceous and calcareous materials with no additions subsequent to calcination excepting water and calcined or uncalcined gypsum.

Pycnometer—A calibrated bottle used for measuring the volume and weight of a liquid in determining its specific gravity; a small calibrated bottle for determining the specific gravity of grains or small fragments.

Quartering—The method of reducing the size of a test sample by dividing it into four parts and rejecting alternate quarters. This process is continued until the sample is small enough for the necessary tests.

Refined Tar—Tar freed from water by evaporation or distillation which is continued until the residue is of desired consistency; or a product produced by fluxing tar residuum with tar distillate.

Reinforced Concrete—Concrete in which metal is imbedded in such a manner that the two materials act together in resisting forces.

Relative Humidity — Ratio of actual density (or pressure) of existing vapor, to maximum possible density (or pressure) at the same temperature, expressed as a percentage.

Retarder—A compound, usually some form of calcium sulphate, added to portland cement during manufacture to control the rate of set.

Rock Asphalt—Sandstone or limestone naturally impregnated with asphalt.

Rounded Fragments—A term referring to particles of aggregate having the corners and edges rounded.

Sample—A part of a material presented as evidence of the quality of the whole.

Sand—The fine granular material, usually passing the number 4 sieve, resulting from the natural disintegration of rock, or from the crushing of friable sandstone rock.

Sandstone—A typical sandstone is composed essentially of rounded grains of quartz, with or without interstitial cementing material, with the larger grains tending to be more perfectly rounded than the smaller ones.

Schists—A crystalline rock that can be readily split or cleaved because of hav-

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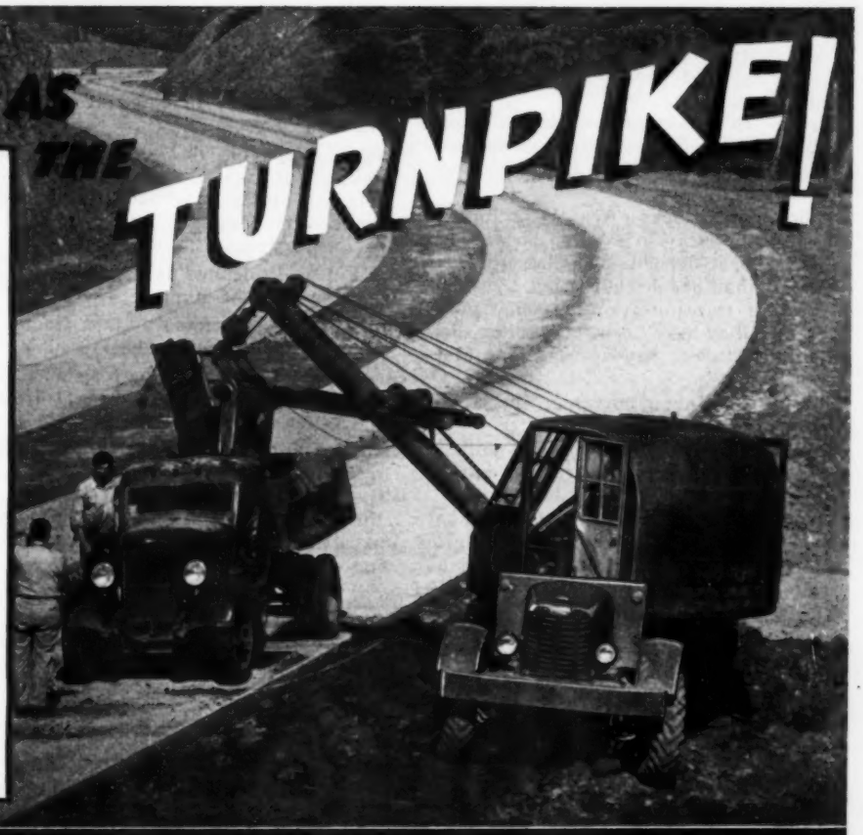

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ing a foliated or parallel structure, generally secondary and developed by shearing and recrystallization under pressure.

Screen—In laboratory work, an apparatus in which the apertures are round. Used for making sieve analyses of aggregates.

Sedimentary Rocks—Are those formed from the decay of existing strata with subsequent deposition of the solid material that has been carried by agencies of transportation to some point where they have been redeposited. Examples are: sandstone, limestone, shale, etc.

Set—The stiffening of cement paste following the mixing with water.

Shale—A material composed essentially of silica and alumina, which has in addition, a more or less thinly laminated structure. This structure has been imparted by the natural stratification of extremely fine sediments by pressure.

Shear (In Soil)—May be defined as the resistance to lateral movement produced by a given vertical load.

Shrinkage Limit—In soil technology, the moisture content, expressed as a percentage of the dry weight, required to fill the pores of a soil sample which has been dried to constant weight from a moisture content sufficient in amount to fill the soil pores completely.

Sieve—In laboratory work, an apparatus in which the apertures are square. Used for making sieve analyses of aggregates.

Silt—Consists of the finer particles of rock substance and ranges in size from 0.05 to 0.005 mm.

Silt (In Soils)—That material passing a number 270 sieve having a grain diameter of greater than 0.005 mm.

Slate—An argillaceous rock in which fissility has been developed by pressure.

Sling Psychrometer — A psychrometer containing matched dry and wet bulb thermometers suitably mounted for swinging through the atmosphere, for simultaneously indicating dry and wet bulb temperatures. The thermometer shall be so mounted as to act independently and to face the air current during the swinging.

Slump—The vertical distance which concrete subsides from its molded shape, when tested for consistency by the standard method. (Fig. 5.)

Fig. 5—Slump Test for Concrete, Showing Slump Cone, Tamping Rod, and Measuring of Slump of the Concrete
Photo by Public Roads Administration

Sodium Hydroxide—The chemical Na(OH) ued in making the organic matter test on sands.

Sodium Sulphate—The salt, either anhydrous (Na_2SO_4) or crystalline (Na_2SO_4, $10H_2O$) is used in making the sodium sulphate test for soundness of aggregates.

Soil Fines—Is defined as that fraction of soil passing the number 40 sieve.

Soil Mortar—Is defined as that fraction of soil passing the number 10 sieve.

Stability of Emulsion—The resistance to separation of the oily material from the water.

Standard Ottawa Sand—A natural sand from Ottawa, Illinois, screened to pass the number 20 sieve and retained on the number 30 sieve. This sand is used as a standard of comparison in testing cement and fine aggregate.

Stone Chips—Small angular fragments of stone containing no dust.

Subangular Fragments—A term referring to particles of aggregate having blunt or slightly rounded edges and corners.

Surface Area—The overall surface of a pulverized material usually expressed in cement technology as square centimeters per gram.

Tamping Rod—Used in determining the unit weight of aggregates. The rod is usually ⅝ in. in diameter and 24 in. in length, with one end tapered for a distance of 1 in. to a blunt bullet-shaped point. (See Fig. 5.)

Tars—Black to dark brown bituminous condensates which yield substantial quantities of pitch when partially evaporated or fractionally distilled, and which are produced by destructive distillation of organic material such as coal, oil, lignite, peat and wood.

Test (Of a Material)—A critical examination by accepted standard test methods.

Testing Machine—A mechanical device for applying a load (force) to a specimen. (Fig. 6.)

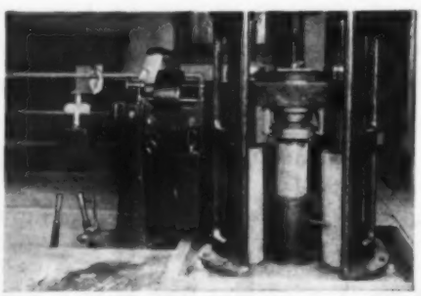

Fig. 6—Testing Machine
Photo by Public Roads Administration

Tetracalcium-Alumino Ferrite—The iron containing compound of portland cement.

Toughness (of Rock)—Is considered to be the resistance offered to fracture under impact, expressed as the final height of blow required by a standard hammer to cause fracture of a cylindrical test specimen 25 mm. by 25 mm. (Fig. 7.)

Trap Rock—Includes the dark-colored, fine-grained and dense igneous rocks composed essentially of the ferromagnesian minerals, basic feldspars, and little or no quartz.

Tricalcium Aluminate (C₃A)—One of the alumina compounds in portland cement. Gives off a large amount of heat on hydration and reacts with sulphates in solution to form calcium sulphoaluminate.

Tricalcium Silicate (C_3S)—The principal compound of portland cement and the one chiefly responsible for strengths at early ages.

Turbidimeter — An instrument which measures the intensity of light passing through a given suspension. Such an instrument is used for measuring the specific surface of cements inasmuch as the intensity of light passing through a suspension of cement is proportional to the specific surface.

Unit Weight of Aggregate—This test consists of determining the weight of the material which will occupy a cubic foot. The unit weight may be expressed either as dry, loose or dry, rodded.

Vapor Pressure—Component of atmospheric pressure caused by presence of water vapor, usually expressed in inches of mercury.

Vertical Illumination—The illumination of a microscopic specimen by reflected light. Used in the study of thin sections of cements and rocks.

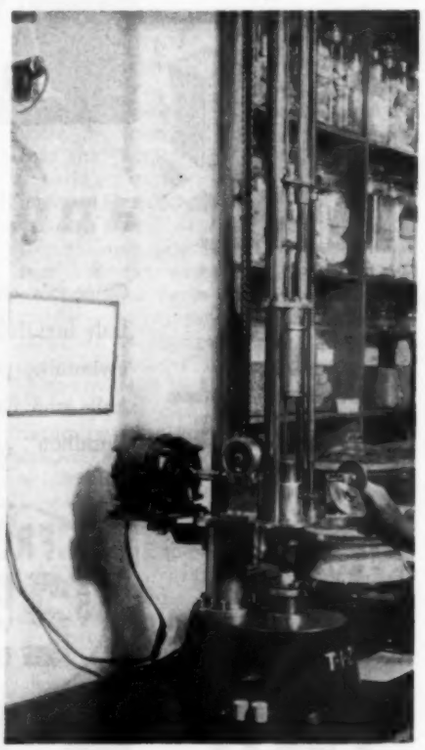

Fig. 7—Page Impact Machine for Making Toughness Tests of Rock. Note Two Test Specimens at Base of Machine
Photo by Public Roads Administration

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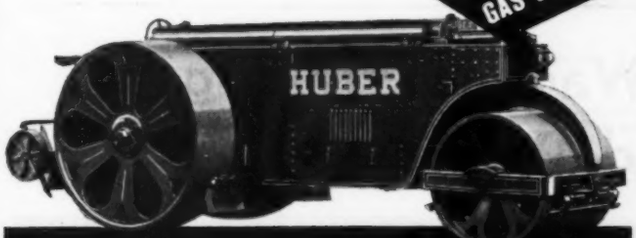

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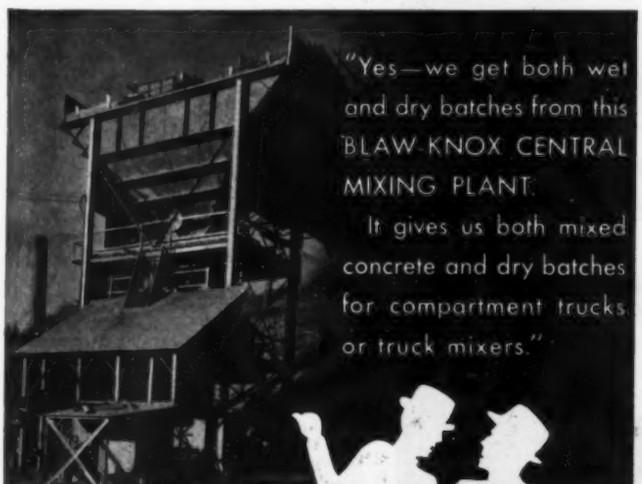

"Yes—we get both wet and dry batches from this BLAW-KNOX CENTRAL MIXING PLANT.

It gives us both mixed concrete and dry batches for compartment trucks or truck mixers."

No matter how varied and involved the concrete requirements on your job might be—Blaw-Knox will design a Central Mixing Plant to solve your problems economically.

Stationary or floating plants, manual or automatic in operation, have been furnished for hundreds of jobs. See them in Catalog No. 1566.

14

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CENTRAL MIXING PLANTS

LET THE HIGHWAYS THEMSELVES MAKE YOUR PIPE DECISION

There is no test more conclusive than performance, and it is here that GOHI Corrugated Pipe demonstrates its amazing endurance, its ability to deliver trouble-free service under the most severe conditions at the lowest per year cost. Economical to buy, to install, to maintain, GOHI Corrugated Pipe is the logical answer to highway and other drainage problems. Complete information and copy of 72-page book on modern culvert practice on request. Address fabricator nearest you.

GOHI Pipe meets Copper-Bearing Pure Iron requirements in all specifications published by nationally recognized specifying authorities.

New England Bolt Co.	Everett, Mass.
Central Culvert Co.	Ottumwa, Iowa
Capital City Culvert Co.	Madison, Wis.
Bancroft & Martin Rolling Mills Co.	S. Portland, Me.
Denver Steel & Iron Works Co.	Denver, Colo.
The Lane Pipe Corporation	Bath, N. Y.
Dixie Culvert Mfg. Co.	Little Rock, Ark.
St. Paul Corrugating Co.	St. Paul, Minn.
The Newport Culvert Co.	Newport, Ky.

GOHI PIPE CORRUGATED

GOHI CULVERT MANUFACTURERS, INC., NEWPORT, KY.

Vicat Ring—A rigid conical ring, part of the Vicat apparatus used in determining normal consistency and time of set of cement. The dimensions are as follows: (Fig. 8)
Inside diameter at bottom.....7 cm. (2.75 in.)
Inside diameter at top.....6 cm. (2.36 in.)
Height.....4 cm. (1.57 in.)

Viscosity—The measure of the resistance to flow of a bituminous material, usually stated as the time of flow of a given amount of the material through a given orifice.

Voids—The spaces or openings between particles of a material in mass.

Volume Change (Of Soils)—Is a term used to indicate the expansion and contraction of soils as the water content changes.

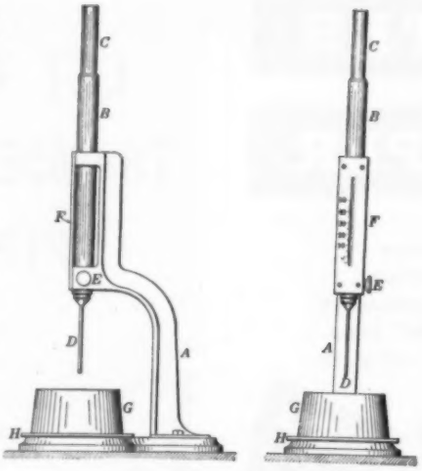


Fig. 8—Vicat Apparatus

Water-Cement Ratio—The ratio of the weight (or volume) of the water to the weight (or volume) of the cement in mortar or concrete mixes.

Water Gas Tars—Tars produced by cracking oil vapors at high temperatures in the manufacture of oil gas.

Weathering Tests (Of Aggregates)—These tests usually consist of subjecting the material to sodium sulphate, or magnesium sulphate soundness tests; or to alternate freezing and thawing. Such tests simulate the natural weathering agencies.

Workability (Of Concrete)—That property which is inversely proportional to the effort required to mix and place concrete in order to obtain a uniform and homogeneous product.

Yield—The factor obtained by dividing the volume of the resulting concrete by the volume of the aggregate mixed.

Meet Murray D. Van Wagoner, Michigan's Governor Elect and Present State Highway Commissioner

FOR the first time in its history, Michigan will have an engineer as governor January 1 when State Highway Commissioner Murray D. Van Wagoner becomes the state's thirty-third chief executive.

Van Wagoner, who is now completing his second four-year term as state highway commissioner, will succeed Governor Lauren D. Dickinson as head of the state government.

In campaigning, Van Wagoner, former president of the American Road Builders' Association, stood squarely on his record as highway commissioner, claiming that the state needed "engineering in government."

Van Wagoner's rise to the highest post in Michigan's state government has been exceedingly rapid. In 1932 he held the rather unimposing job of drain commissioner of Oakland County, Michigan. Today, at 42, just eight years later, he is about to become the state's highest public official.

Born on a farm in the Michigan Thumb the day after St. Patrick's Day, it was only natural that he acquired the nickname of "Pat". And that is the name he is known by today by a host of friends throughout the state.

After graduating from the Pontiac High School, Van Wagoner enrolled in the engineering college at the University of Michigan, specializing in highway engineering and highway transport. He received his degree as a civil engineer from that institution in 1921.

For three and a half years following graduation, Van Wagoner was employed by the Michigan State Highway Department as resident construction engineer and division bridge engineer with headquarters at Alpena. He later organized his own private engineering office in Pontiac and conducted a successful private business for seven years.

In 1930 he was elected drain commissioner of Oakland County, and two years later was reelected to the office. In the spring of 1933, Van Wagoner was accorded the unanimous nomination of the democratic state convention for the office of state highway commissioner. He was elected to that office in the April election of 1933 for a four year term and relected to a second term in the spring of 1937.

During the last seven and one-half years, Van Wagoner has carried out Michigan's most intensified roadbuilding program, constructing or hard-surfacing one-third of the state's total of 9,000 miles of highway, building 172 bridges and 76 grade separations.

By advance planning he has made Michigan consistently the first state in the nation to win Federal approval and money for new projects. Recently, the Michigan State Highway Department began construction of the first military highway in the United States at Fort Custer under the present national defense program.

Van Wagoner has also attracted national attention on tourist highway development in Michigan by building 1,000 miles of scenic and shoreline highways. He also won national fame for opening 160 roadside parks and installing 3.500 picnic tables. Other states now are copying the plan.

His tree planting and roadside landscaping program caused A. D. Taylor, landscape consultant of the U. S. Forest Service, to declare recently that Michigan has the most beautiful roadsides in America.

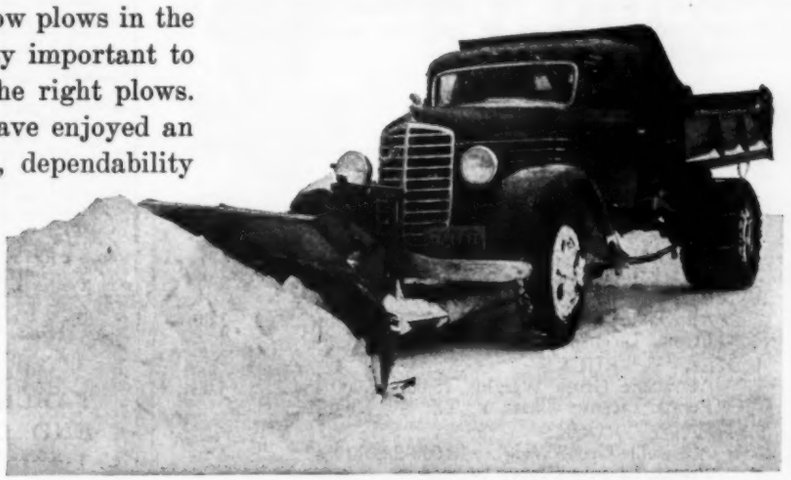
Van Wagoner's administration as president of the American Road Builders' Association was featured by a westward expansion of the organization together with a renewed attempt for a united front in every state against diversion of highway revenues.

Commissioner Van Wagoner is a member of the American Society of Civila Engineers and the Michigan Engineering Society. He is a member of the Presbyterian Church, the American Legion, Rotary Club, and the Masonic Order. He is married and has two daughters, and makes his home in Lansing.

DEPENDABLE WEAPONS FOR SNOW FIGHTING

You wouldn't think of changing snow plows in the middle of a blizzard. So it's mighty important to know in advance you are getting the right plows. For 32 years Baker Snow Plows have enjoyed an enviable reputation for sturdiness, dependability and economical performance. Bakers will never let you down. The new line of Baker Truck Snow Plows includes many improved models in "V", reversible blade and one way types for any motor truck.

Send for attractive new Bulletin 829 on Truck Snow Plows—also special bulletins on tractor plows.



A Baker Reversible Blade Snow Plow doing a clean job by getting right down to the pavement surface, thanks to the Baker Sectional Tripping Blades.

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New York's Popular

HOTEL LINCOLN

44TH TO 45TH STS. AT 8TH AVE.

1400 ROOMS *from* **$3.**

Each with Bath, Servidor, and Radio. Four fine restaurants acclaimed for cuisine.

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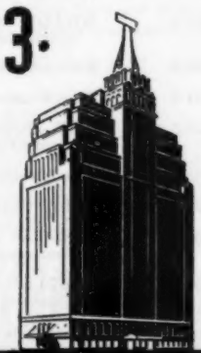
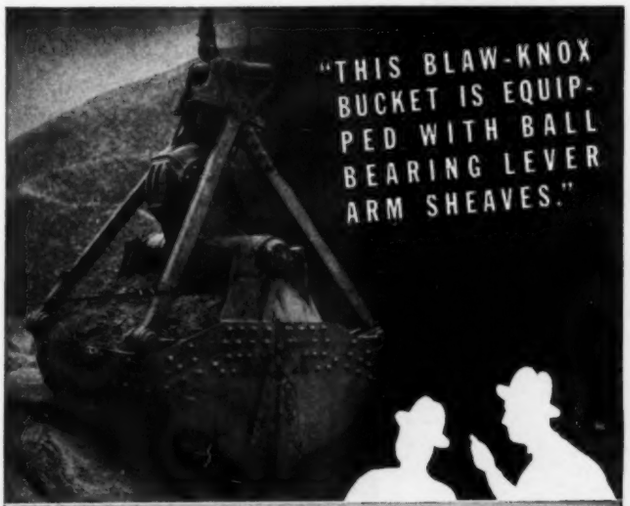


IN THE CENTER OF MID-TOWN NEW YORK



As a matter of fact this feature is standard equipment and does not cost more. It is especially desirable where the bucket handles loose granular materials because it keeps lubrication in and dirt out. This and many other desirable features of Blaw-Knox Buckets is fully described and illustrated in Bulletin No. 1606. Write for it today.

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BLAW-KNOX *Digging and Rehandling* **BUCKETS**

BLAW-KNOX DIVISION
OF BLAW-KNOX CO.
Farmers Bank Bldg. Pittsburgh, Pa.

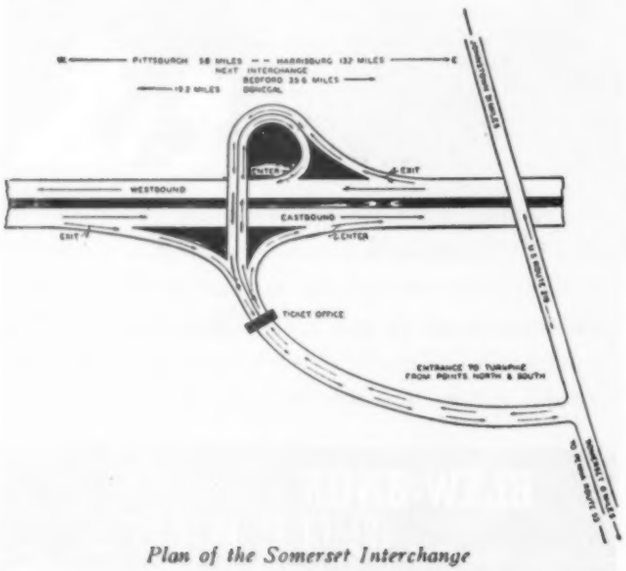
PENNSYLVANIA TURNPIKE FARE SCHEDULES

Toll rates on the Turnpike are covered in a booklet of schedules issued by the Commission on October 1st. There are eleven classes of vehicles, with fares for the full length trip as follows:

Class	*Vehicle Type*	*Full Length Fare*
1.	MOTORCYCLES	$ 1.00
2.	PASSENGER CARS, PASSENGER CARS AND TRAILERS, LIGHT TRUCKS Allowable Gross Weight: up to 7,000 lbs. Penna. License Class: R, S. Full Length Round Trip Fare for Passenger Cars without Trailers	$ 1.50 2.25
3.	MEDIUM TRUCKS Allowable Gross Weight: 7,000-15,000 lbs. Penna. License Class: T, U, RZ, SZ.	3.00
4.	HEAVY TRUCKS Allowable Gross Weight: 15,000-18,000 lbs. Penna. License Class: V, TZ.	4.00
5.	HEAVY TRUCKS Allowable Gross Weight: 18,000-22,000 lbs. Penna. License Class: W, UZ.	4.50
6.	HEAVY TRUCKS Allowable Gross Weight: 22,000-26,000 lbs. Penna. License Class: Y, Z, VZ.	5.00
7.	HEAVY TRUCKS AND TRAILER TRUCKS WITH SEMI-TRAILERS Allowable Gross Weight: 26,000-30,000 lbs. Penna. License Class: WZ.	6.00
8.	HEAVY TRUCKS AND TRACTOR TRUCKS WITH SEMI-TRAILERS Allowable Gross Weight: 30,000-39,000 lbs. Penna. License Class: YZ, ZZ.	7.50
9.	TRUCKS AND FULL TRAILERS Allowable Gross Weight: 39,000-62,000 lbs. (No distinguishing license letters on trailer combinations.)	10.00
10.	BUSSES Up to and Including 12 Passengers Penna. License Class: O.	3.00
11.	BUSSES 13 Passengers or Over Penna. License Class: O.	6.00

The complete rate schedule for Class 5 vehicles is given herewith. Other schedules are in the same form.

Distances are not given in the official booklet. The accompanying table of mileages is from a Turnpike pamphlet issued by Standard Oil Company of Pennsylvania.



Plan of the Somerset Interchange

INTER-CHANGE	IRWIN	NEW STANTON	DONEGAL	SOMERSET	BEDFORD	BREEZEWOOD	FT. LITTLETON	WILLOW HILL	BLUE MT.	CARLISLE
NEW STANTON	.25									
DONEGAL	.65	.45								
SOMERSET	1.20	1.00	.60							
BEDFORD	2.20	2.00	1.60	1.05						
BREEZEWOOD	2.70	2.50	2.10	1.55	.50					
FT. LITTLETON	3.30	3.10	2.70	2.20	1.20	.70				
WILLOW HILL	3.65	3.45	3.05	2.55	1.55	1.05	.40			
BLUE MT.	4.00	3.80	3.40	2.90	1.90	1.40	.75	.35		
CARLISLE	4.50	4.30	3.90	3.40	2.40	1.90	1.25	.85	.50	
MIDDLESEX	4.50	4.30	3.90	3.40	2.40	1.90	1.30	.90	.60	.10

Pennsylvania Turnpike Commission
PENNSYLVANIA TURNPIKE
Fare Schedule
Vehicle Type: HEAVY TRUCKS
Allowable Gross Weight: 18,000-22,000 Lbs.
Penna. License Class: W, UZ
Full Length Fare: $4.50
CLASS 5

TABLE SHOWING MILES FROM EACH END OF PENNSYLVANIA TURNPIKE TO INTERCHANGES, TUNNELS, AND GAS STATIONS

Eastbound			Westbound
0		**IRWIN INTERCHANGE** (Western terminus) (Connects with U. S. Rt. 30)	159.6
8.5		**NEW STANTON INTERCHANGE** (Connects with U. S. Rt. 119)	151.1
11.7		New Stanton Gas Station	W-B* 147.9
23.7		**DONEGAL INTERCHANGE** (Connects with State Rts. 711 and 31)	136.0
33.0		†Laurel Hill Tunnel—4541 feet	126.7
35.8	E-B**	Laurel Hill Gas Station	123.8
42.9		**SOMERSET INTERCHANGE** (Connects with U. S. Rt. 219)	116.8
45.4		Somerset Gas Station	W-B 114.2
55.8		Allegheny Tunnel—6070 feet	103.9
63.2	E-B	New Baltimore Gas Station	96.4
78.5		**BEDFORD INTERCHANGE** (Connects with U. S. Rt. 220)	81.1
80.3	E-B	Midway Gas Station	W-B 79.3
95.9		**BREEZEWOOD INTERCHANGE** (Connects with U. S. Rt. 30)	63.8
98.1		Rays Hill Tunnel—3532 feet	61.5
102.9		Sideling Hill Tunnel—6782 feet	56.7
104.5		Cove Valley Gas Station	W-B 55.1
112.6		**FORT LITTLETON INTERCHANGE** (Connects with U. S. Rt. 522)	47.1
119.8		Tuscarora Mountain Tunnel—5326.5 feet	39.9
120.9	E-B	Path Valley Gas Station	38.7
121.6		**WILLOW HILL INTERCHANGE** (Connects with State Rt. 75)	38.0
131.0		Kittatinny Mountain Tunnel—4727 feet	28.7
131.9		Blue Mountain Tunnel—4339 feet	27.7
134.3		**BLUE MOUNTAIN INTERCHANGE** (Connects with State Rt. 944)	25.3
135.5		Blue Mountain Gas Station	W-B 24.1
152.1	E-B	Carlisle Gas Station	7.5
157.5		**CARLISLE INTERCHANGE** (Connects with State Rt. 34)	2.1
159.6		**MIDDLESEX INTERCHANGE** (East. terminus) (Connects with U. S. Rt. 11)	0

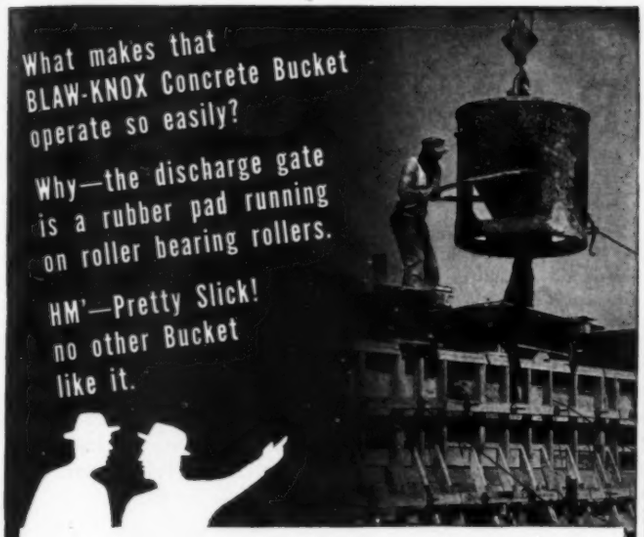
†All distances to tunnels are given to middle of each tunnel.

No crossing of center strip. No U turns.

In emergency, park on the right-hand shoulder; you will be served with gas by the attendant from the opposite side.

*W-B indicates Gas Stations for Westbound traffic *ONLY*.

**E-B indicates Gas Stations for Eastbound traffic *ONLY*.


What makes that BLAW-KNOX Concrete Bucket operate so easily?
Why—the discharge gate is a rubber pad running on roller bearing rollers.
HM'—Pretty Slick! no other Bucket like it.

• Controllable discharge, Blaw-Knox CONCRETE BUCKETS are a popular concrete placing unit. Used by contractors everywhere.

Send for a copy of the catalog on Blaw-Knox Concrete Buckets, No. 1586.

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BLAW-KNOX *Roller Gate*
CONCRETE BUCKETS

No Washers to Replace!

"GJ-BOSS"
GROUND JOINT
HOSE COUPLING
STYLE X-34

A washerless, leakproof coupling, designed and built to insure maximum safety, reliability and economy, in every type of service.

No service interruptions to replace lost or worn-out washers. Copper insert in spud fits rounded head of steel stem, forming soft-to-hard metal seal that *will not leak*, regardless of wear. Cadmium plated—rustproof. Sizes ½" to 4" inclusive, with strong 4-bolt malleable iron "BOSS" Interlocking Offset Clamp on 1" and larger; 2-bolt clamp on ⅞" and smaller.

NOTE: For Washer Type Female Coupling, specify "BOSS" Style W-16. Companion Male Coupling, "BOSS" Style MX-16.

Stocked by Leading Rubber Manufacturers and Jobbers.

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HERE'S YOUR BEST LOCATION

In the very center of the business and entertainment districts, The Wisconsin offers 450 "hospitality units"—rooms of superior comfort, plus a genuinely friendly atmosphere. Coffee Shop and Cocktail Lounge. Garage and parking lot.

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WITH BATH from $2.50 without bath $1.50

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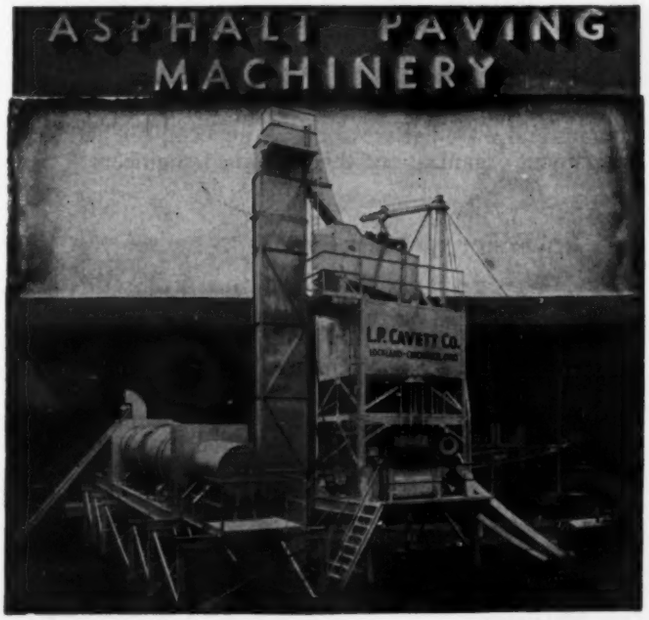
Owner operated by the Milwaukee Hotel Wisconsin Co.



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EDITORIAL

AMERICAN DICTATORS

COLLECTION of the pernicious political 2 per cent for campaign funds from state (and some county) highway department employees rolls merrily onward. Politicians have imposed a subrosa racket on highway department employees. The writer quotes the following from a letter he received on this question to show how detrimental to one's own feeling of freedom is this pernicious racket:

"The mouths of everyone are closed in the ..... highway department * * * ."

"I was in the department about a year and paid 2 per cent monthly and was informed that everyone paid 2 per cent * * * . There were a half dozen or more men in the office who did not understand the work—I do not know their history—they were there because they were entitled to a job. [As a party worker not as an engineer.—ED.]"

" * * * he has a sponsor, some politician who signs his credentials and to whom he looks for orders and protection. Sponsors are more important than the District Engineer."

The fundamental basis of a racket is the extraction of money from an individual, under duress. Highway department employees desire to give away 2 per cent of their wages or salaries just about as willingly as they desire a toothache regularly. Either they donate the 2 per cent or they lose their jobs and they know it, even though the receipts may be labeled "voluntary contribution."

Isn't it a wonderful state of affairs when precinct captains and ward heelers are more important in highway department organizations than qualified engineers?

KEEP THE BALL ROLLING

ACTION has been started in Idaho that should be followed up by resolutions from engineers and contractor groups in that state. I refer to increased salaries for engineers of the state highway department. In reply to an editorial published in the September issue of ROADS AND STREETS, Mr. Earl W. Murphy, Executive Secretary, Office of the Governor, State of Idaho, says:

Mr. V. J. Brown,
Publishing Director,
Gillette Publishing Company,
Chicago, Ill.

Dear Mr. Brown:

Governor Bottolfsen has asked me to acknowledge your letter and the preprint of an editorial from the September issue of ROADS AND STREETS.

It has been the feeling of Governor Bottolfsen for some time that engineers of the Bureau of Highways in this State are for the most part underpaid. An upward revision would have been made during the present biennium if it had not been for a serious curtailment in the Highway Bureau revenues.

It is the plan of Governor Bottolfsen to request an appropriation at the coming session of the Legislature in January, 1941, sufficiently large to permit increases in the salary scale of the engineers.

Thank you for calling this editorial to the attention of Governor Bottolfsen.

Yours very truly,
Earl W. Murphy,
Executive Secretary.

Curtailment of highway revenues at the next legislature must be prevented so no excuse can be raised against paying the engineers half way decent salaries. The writer knows that the Bureau is going to lose men. They have filled out applications already for positions of less responsibility and higher pay. Idaho will be wise to protect the organization. The rich state can afford it.

Keep the ball rolling by local action.

BRICK PAVEMENT FILLERS

WHO can answer the question of how asphalt filler for brick pavement became standard practice? If so, can the "Why" be answered?

The writer's reflection about brick pavement fillers runs about as follows:

Prior to 1917, sand only was generally employed. About this time Alan J. Parish, then a contractor, patented a monolithic construction which he made available without charge to those desiring to build monolithic. The writer recalls some work of this kind built in Iowa. Several blowups occurred on this project as probably occurred on others built throughout the country at that time. Expansion joints were not provided then as well as they are now.

The writer reasons that a search was made for preventing blowups which were attributed to excessive expansion and asphalt came into the picture.

Whatever the reason for its introduction, it usually left the brick surface covered completely with asphalt. The surfaces were and still are, slippery because of the thin coat of asphalt left on the surface of the brick.

Attempts to correct this condition have resulted in a process of construction in which the asphalt is cut loose and removed from the surface, leaving the joints filled flush with surface.

Investigation made by the writer indicates that this is not yet the solution. The asphalt filler exudes or is squeezed out, or both, and the pavement is slippery just as before. Not only is this one of the inadequacies of asphalt fillers, but there is a lack of bridging strength also.

With asphalt fillers the brick, in the summer heat, float in an asphalt bath.

Cement grout filler has merit in creating pavement strength with brick, which has not been given due consideration.

IMPORTANT CONTRACTORS' MEETING

Additional to what I had to say last month about an important meeting to be held soon for contractors, and particularly road and street contractors, is that this meeting will be in New York City in January. Some of the dollars and cents savings I spoke about will require a united front by contractors in a joint action. More specific information will be given next month.

NEW BOOKS

ENGINEERING TERMINOLOGY

Definitions of Technical Words and Phrases

Second Edition

By V. J. Brown
Publishing Director, ROADS AND STREETS
and
D. G. Runner
Assistant Materials Engineer,
U. S. Public Roads Administration

A word or phrase in one branch of engineering may have an entirely different meaning in some other branch. Various branches of applied engineering, all of which spring from the common root of natural and physical science, have found it expedient to develop a specialized vocabulary. This book is a step toward avoiding misunderstanding and difficulty from this cause for purposes of contracts, correspondence, agreements, price lists, specifications, etc., between the different branches of engineering, the public, and other professions. It is arranged in dictionary form. The book fills a need or want in engineering literature. It also initiates the standardization of engineering terms. Valuable appendices include English-Spanish terms; Spanish-English words; German-English aggregate terms; Symbols for Hydraulics; Standard Pump Classifications; Materials for Pumping Various Liquids; Abbreviations for Scientific and Engineering Terms; Symbols for Mechanics, Structural Engineering and Testing Materials; Weights and Measures; Conversion Factors.

439 pages—Dark red buckram binding.

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SOIL STABILIZATION

By V. J. Brown
Publishing Director, ROADS AND STREETS
C. A. Hogentogler
Senior Highway Engineer,
U. S. Public Roads Administration
C. A. Hogentogler, Jr.
Research Engineer,
George Washington University
Frank H. Newman, Jr.
Binder Research Engineer,
Texas State Highway Department
C. M. Lancaster
Soils Engineer,
Missouri State Highway Department
E. S. Barber
Junior Highway Engineer,
U. S. Public Roads Administration

This book is reprinted from a series of articles published in ROADS AND STREETS. Demand for the series was world wide. The book treats of fundamentals of soils mechanics and soil stabilization such that the average engineer can get a complete understanding of this new branch of highway engineering.

It is the best treatise on the subject so far published, and is a vital need for the engineer who is considering low cost road improvement or grading embankment control.

Profuse illustrations tell more than words could.

141 pages—Hard binding.

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GEOLOGY FOR CIVIL ENGINEERS

As Related to Highway Engineering

By Delmar G. Runner
Assistant Materials Engineer,
U. S. Public Roads Administration

Rock and soils, and their characteristics, both physical and chemical, as well as their classifications and geographical distributions are discussed in such a way as to make this book particularly valuable for civil engineers and for engineering colleges. The chapters on material surveys, together with those on the petrographic microscope and its use constitute a real contribution to the fund of knowledge on engineering geology. This is the first time that the theories of general geology have been correlated by a competent engineer and geologist with the requirements of highway engineering. The book is written from the engineer's viewpoint for engineers. It puts into usable, understandable language the facts concerning rock formations and gravel deposits hardness or toughness values, how to recognize suitable or undesirable materials, and the source or origin of rock types. It is particularly useful to those engineers charged with the responsibility of materials selection for construction or maintenance work.

CONTENTS

Introduction; Value of Engineering Geology; Road Material Survey Methods; Relation of Geological Formations to Material Surveys; The Common Rock Making Minerals; Igneous Rocks; Metamorphic Rocks; Sedimentary Rocks; Origin and Roadbuilding Properties of Shale; Origin and Roadbuilding Properties of Caliche; Origin and Roadbuilding Properties of Limerock; Origin and Composition of Clays; Preparation and Properties of Blast Furnace Slag; Low Cost Road Surfaces; Petrography and the Quality of Rock; Sand and Gravel Deposits; Soils and Soil Tests; Glossary of Geological Terms; Glossary of Highway Terms; Names and Addresses of Highway Departments; States With Geological Commissions; Testing Material Procedures.

310 pages—Dark red buckram binding.

PRICE, **$5.00** PLUS POSTAGE

Gillette Publishing Co.,
330 South Wells Street,
Chicago, Ill.

Gentlemen: Please send me the following book or books, which I will pay for or return within 10 days:

☐ Soil Stabilization $2.00

☐ Engineering Terminology $4.00

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NEW EQUIPMENT and MATERIALS

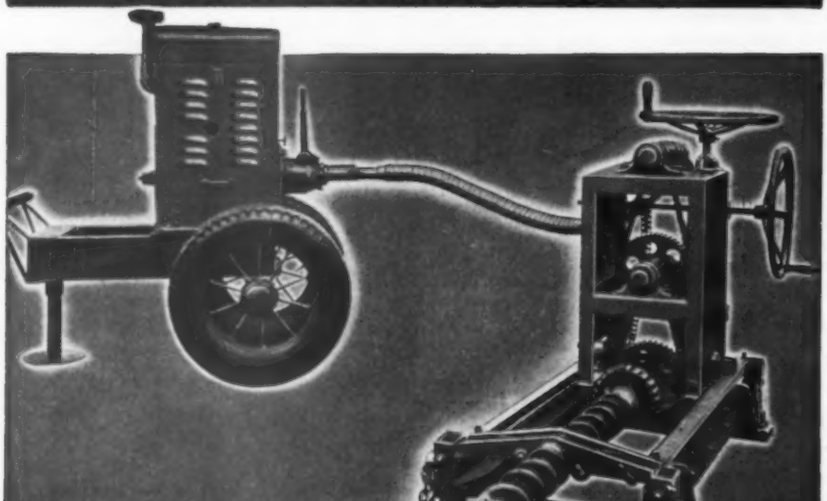
New Portable Roller

The Galion Iron Works & Mfg. Co., of Galion, Ohio, has announced a light weight, general service, portable roller. Among the specifications are the following:

Weight on compression roll, 5760 lbs. Weight on tires, 1700 lbs. Total weight, 7460 lbs. Weight on compression roll may be increased up to 8100 lbs. by adding water. Low speed 1.5 M.P.H., high speed 5.0 M.P.H. These two speeds are the same both forward and reverse. Speeds may be lowered by partially closing the throttle. Wheel base, 78 in. Rolling width, 42 in. Length, overall with towing tongue, 13'-6¼". Overall without towing tongue, 11'-6¼". Height, overall, 5'-11¼". Width, overall, 5'-3½". Ground clearance, under steering axle 12". Turning radius, 15'-0" to outside. Motor, 4 cylinder, 3¼ x 4 in., 25.5 H.P. at 1500 R.P.M. Automotive type steering gear. Compression under roll without water, 137 lb. per sq. in.—with 2300 lb. water in roller, 191 lb. per sq. in. The roller is equipped with hand operated hydraulic pump and double acting ram to lift the compression roll off the road 8 to 9" for towing. In the towing position about 3,775 lbs. of the roller weight is on the truck and about 4,400 lbs. on the tires.

Full details may be had from Galion's Bulletin 260, on request.

Parmanco
HORIZONTAL DRILLS



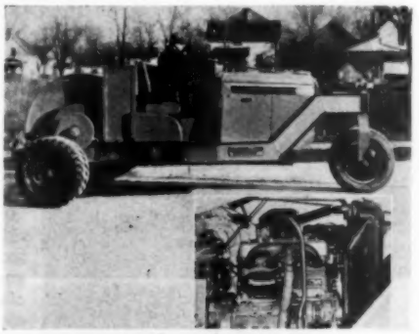
Stop . . . AND THINK!

That cutting pavements causes more damage than traffic.
That trenched yards are eyesores for years.
That public hazard can be eliminated.
That obstructing traffic is not necessary.
That you now can put services in to grade.
That you can save money, time and create good will by using PARMANCO.
PARMANCO Utility Drills are made in two sizes, PARMANCO JUNIOR for drilling 4 inch holes up to 50 feet, and the PARMANCO GENERAL UTILITY for drilling longer distances or drilling larger holes.
ALSO PARMANCO SENIOR for drilling up to 14" holes.
Write us for details of actual performances during last 30 days.

WRITE US YOUR DRILLING PROBLEMS
PARIS MANUFACTURING CO., INC.
PARIS, ILLINOIS

New Riddell Roller Powered by Hercules Diesel Engine

A general purpose road roller, built to handle the regular work of 6 to 8-ton rollers of the conventional type—but with the added advantage of speedy transportability



The New "Whizzard" Roller and Its "Hercules" Power Plant

—has been developed by the W. A. Riddell Corporation of Bucyrus, Ohio.

Known as the "Whizzard," this roller is equipped with a pair of dual pneumatic-tired rear wheels, mounted on an assembly at the rear of the frame. These wheels, together with a transport gear, swing back out of the way of the roller when it is in operation. When the rolling job has been completed, it is not necessary to load the roller on a truck or lorry, or to tow it. Instead, by means of a very simple mechanism, the dual tired rear wheels are quickly swung into road position, thereby engaging a gear in the driving mechanism and stepping up the speed for driving the roller on pneumatic tires at regular traffic speeds. It is said that the entire operation of changing the unit over for quick transportability can be easily accomplished by one man in less than four and one-half minutes. The reverse operation can be performed in the same length of time.

Compression rolls are two in number, with a combined rolling width of 44 in. These rolls are of steel plate construction, electrically welded and water-tight. They are so constructed that they can be filled with water or other material, adding approximately 3300 pounds to the weight of the machine.

The design of the roller is such that 85 per cent of the total weight of the machine is concentrated on the rollers. Only sufficient weight is carried on the front end and front tires to facilitate easy steering. In operation the speed of the roler is 1½ to 6 miles per hour. In operation the speed of the roller is 1½ to 6 miles per hour. The roller is said to be extremely efficient for all types of general purpose rolling. It is powered by Hercules Diesel Engine Model DOOC, 4-cylinder, 4 in. x 4½ in.

Three New Lightweight Vibrators

Marvel Equipment Manufacturers, 838 West Hubbard St., Chicago, Ill., have announced the following additions to their line of concrete vibrators for various purposes.

Model EV-A, Vertical Hand Motor Set —½ H.P. motor—3450 V.P.M.—Weight 46 lb.

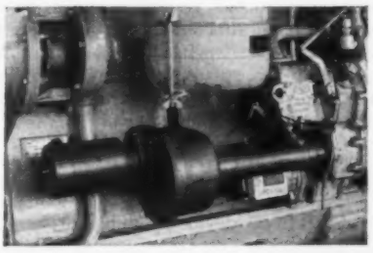
Model GV-O, Gasoline Direct Connected Set—developing 1¼ H.P. plus producing 4000 V.P.M.—mounted on swivel base—1⅝" head—10 ft. ½" flexible shaft operating in Wyco patented inner-liner Casing—weight 90 lbs.

Model EV-O, Hand Electric Set—on swivel base with ventilated air filter and step-up to 5200 V.P.M., ½ H.P. motor, 7 feet drive shaft in patented casing with 1⅝" head—weight 65 pounds.

New Diesel Starter

A new device for starting the small two-cylinder engines on Caterpillar Diesel engines, has just been introduced by the H. K. Porter Co., Inc. (address furnished on request). The device, operated by electricity, is said to save its cost in a few months by the avoidance of lost operating time.

Originally developed for use in connection with Porter Diesel Locomotives, and recently changed to a form suitable for easy installation on all Caterpillar engines, the new starter can be employed in the operation of Diesel cranes, shovels, bulldozers and all similar equipment. It consists of a conventional automotive type starter, fitted with a Bendix gear which drives a spur gear. An extension shaft attached to the spur gear engages the main crankshaft of the small gasoline engine, thus starting the engine. The entire gear unit is enclosed in a cast iron housing, and provision is made for lubrication of shaft bearings.



The Porter Starting Device

A hand and magnetic switch is also furnished with the assembly. Starting motor may be either 6 or 12 volt, depending upon generator and battery equipment available on the Diesel engine. The manufacturer will furnish complete information and prices upon request.

Harnischfeger Revises Canadian Sales Set-up

The Harnischfeger Corporation of Milwaukee has rearranged the supervision of its Canadian business. Henceforth, all matters pertaining to Canada will be under the supervision of Deane S. Holt of the company's export division. This change applies to the whole of Canada except the provinces of British Columbia and Alberta, which will remain under the jurisdiction of the Harnischfeger Seattle office. The Harnischfeger Corporation manufactures excavators, cranes, hoists, welders and electrodes.

"Two-In-One" Crushing Rolls Featured on Universal's New "Pacemaker" Quarry Plant

"Pacemaker" is the name of a new compact, portable quarry plant that has just come through its test period and is now available to quarry operators. This plant is equipped with a jaw crusher for primary reduction and a new "two-in-one" roll crusher developed by Universal Crusher Company, one-half of each roll being ¾ in. in diameter smaller than the other.

Secondary reduction is done in two steps, the smaller of the divided rolls giving an initial secondary crushing and the other half, fed from the second deck of the 4 ft. x 8 ft. vibrating screen giving a final secondary crushing. This speeds capacity, rock going in and coming out crushed in a continuous stream.

The crushing cycle is further speeded up by the use of the Universal Rotavator, a rotary elevator, an underslung conveyor and other short cuts. These features all contribute to reduce the weight of the outfit.

The conveyor arrangement also reduces the overall length and the overall moving height. This lower center of gravity makes it roadworthy and easier to maneuver into place on quarry floors.

Power for the unit shown, one of two recently installed, is supplied by a 95 h.p. Caterpillar RD-8 Diesel Tractor.

A capacity of 100 to 130 yards per hour without crowding has been reported on the first installations.

WIND
SNOW
RAIN
DUST
SISALKRAFT
STOPS THEM ALL
Before They Stop You
Nothing else as practical and economical for covering up—closing in—keeping work going in spite of the weather.
SISALKRAFT is the tough, waterproof, windproof, sisal-reenforced paper of endless uses. For example:
Temporary closures — steam-curing concrete — covering machinery and materials — covering aggregate to be heated by steam.
Available in rolls and blankets of almost any width. Inexpensive and durable. Have some on every job!
Write for Prices, Sizes and Samples.
THE SISALKRAFT CO.
Chicago . . . . . 205 W. Wacker Drive
New York . . . . . 101 Park Avenue
San Francisco . . 55 New Montgomery St.

The "Pacemaker" is available with an 18"x24" jaw crusher and 30"x16" or 24"x16" rolls, or 24"x16" rolls with one split; also with a 20"x36" jaw crusher and either a 30"x18" or 40"x20" standard roll crusher or a 30"x16" crusher with the new two-in-one roll.

Fuller information may be had from Universal Crusher Co., Cedar Rapids, Iowa.

New Ford Heavy Duty Dump Truck

Two optional hydraulic hoists, one an arm type, the other a direct lift type, are offered on the 134-inch wheelbase Ford V-8 dump truck pictured above. This truck is available with either the 85 or 95-horsepower V-8 engine and with factory installed frame reinforcements and two-speed axle, when intended for exceptionally heavy duty service with special bodies.

New Adams Grader

A new motor grader of the "engine over drive" type is announced by J. D. Adams Company. This machine is known as the No. 311 and is powered by an International 50 h.p. Diesel engine. It is a medium-size, popular-priced machine, which, it is claimed, is capable of building and maintaining roads from bank to bank, including backsloping.

This new grader is built around an all-welded, box-type main frame originated by Adams several years ago, and now used in all other Adams motor graders and leaning wheel graders. The outstanding advantages of this type of frame, it is claimed, are its strength and rigidity, the unhampered visibility of the blade it affords the operator, and the extremely wide range of blade positions which it permits.

Operating advantages claimed by the manufacturer are: With the same setting of lift linkage, and with blade in center position, the blade can be adjusted from deep ditching position to high bankcutting position in about 40 seconds permitting all adjustments on 90 percent of work to be made without the operator leaving the cab. Blade can be set vertically if desired, and very wide shoulder reach or flat-bottom ditching positions can be obtained. Circle is full revolving and blade can be set to ditch or move dirt with machine operating in reverse gear. Blade can be reversed with scarifier on machine by simply lifting scarifier teeth out.

The Adams No. 311

The No. 311 has eight forward speeds (with high top speeds for traveling), and two reverse speeds. Balanced weight distribution permits surface maintenance at 6 to 7 m.p.h. without objectionable bouncing or vibration.

The wide range of blade adjustments in all directions, tandem drive with low pressure tires and leaning front wheels permit these graders to be utilized on all types of surface, ditch and bank work. Optional equipment includes scarifier, canopy top, cab enclosure, starting and lighting equipment, and V-type snow plow and snow wing.

Full information concerning this machine can be had from J. D. Adams Company, Indianapolis, Indiana.

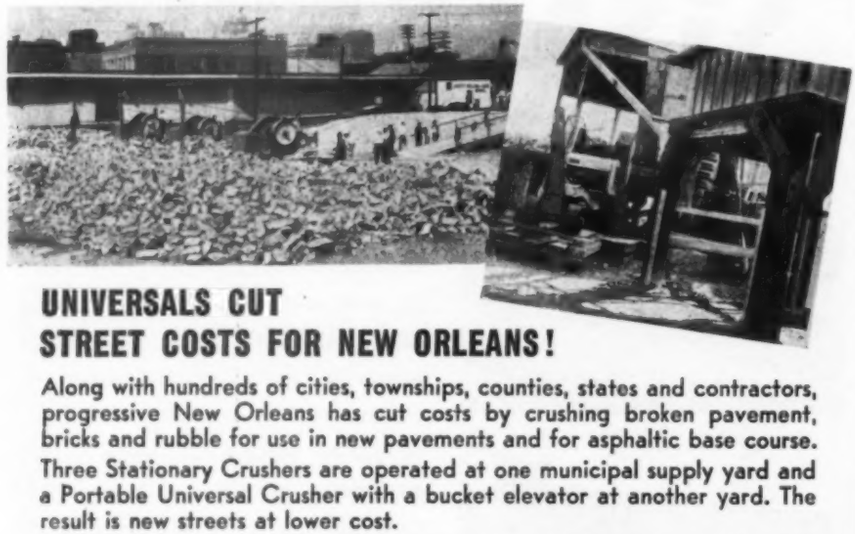
New Line of Truck Mixers

A line of "high dump" truck mixers and agitators has been brought out by The Jaeger Machine Co., Columbus, O. Designed with a high discharge point to meet unusual placing conditions, it is claimed the machines will deliver concrete, low slump or high, over a wider radius, will spout it into higher forms, over material piles, into large floor hoppers. Among the advanced features claimed for this line are: Extra big drums, top loading in one drop; dual-mix action; vacuum operated discharge door; sypho-meter tank with "winter-safety" water booster; advanced design, cab-controlled truck engine drive; two speed, shock-proof transmission; compactness which permits mounting 2-yd. size on short wheelbase trucks. "High Dumps" are supplied in three sizes, 2-yd., 3-yd. and 4-yd. with approximately 50 per cent greater capacity when used as agitators.

Moisture Detecting Instruments

An electrical device brought out by Colloid Equipment Co., Inc. (address furnished on request), and known as the Delmhorst Moisture Detector, tests and measures moisture on the surface and in the interior of all sorts of materials, including earth, concrete, brick and timber. The machine is simple, light, and compact, total weight being from 2 to 4 pounds, depending on the model.

Delmhorst Moisture Detector



UNIVERSALS CUT STREET COSTS FOR NEW ORLEANS!

Along with hundreds of cities, townships, counties, states and contractors, progressive New Orleans has cut costs by crushing broken pavement, bricks and rubble for use in new pavements and for asphaltic base course.

Three Stationary Crushers are operated at one municipal supply yard and a Portable Universal Crusher with a bucket elevator at another yard. The result is new streets at lower cost.

Whether your road material and aggregate requirements are large or small, it will pay you to come to crushing equipment headquarters—Universal—for your needs. Over 50 types of Portable and Stationary Gravel and Quarry Plants; 27 sizes of Jaw Crushers; Crushing Rolls, Screens, Conveyors, Elevators, Bins—everything for producing the most material at the lowest cost per yard. Send for confirming data.

UNIVERSAL CRUSHER COMPANY
631 C AVENUE WEST, CEDAR RAPIDS, IOWA

UNIVERSAL

WITH THE MANUFACTURERS

Davis Succeeds Roberts as President of Athey Other Appointments

At a meeting of the Board of Directors of Athey Truss Wheel Co., October 19, C. Kier Davis, who has been a Vice President and Treasurer, was elected President to fill the vacancy occasioned by the death of James A. Roberts.

George W. Roberts remains Executive Vice President, and was elected Treasurer also.

Joesph Kuchar, who has been active in the Company since its organization, most recently as Chief Engineer, was elected a Vice President.

The other officers and administrative personnel remain unchanged.

W. M. Black Appointed President American Manganese Steel Division

"Amsco's" New President

W. B. Given, Jr., president of The American Brake Shoe and Foundry Company, announces the appointment of W. M. Black as president of the company's American Manganese Steel Division at a meeting of the Board of Directors, October 8. Mr. Black became General Sales Manager of his Division in 1924 and a Vice-President in 1935. He has been with "Amsco" since 1912, with the exception of the war years when he served as a Lieutenant in the U. S. Ordnance Department.

The American Manganese Steel Division was formerly headed by W. E. Crocombe. Mr. Crocombe remains president of the American Forge Division of the company which is now undertaking the production of upset shell forgings in addition to its regular business, to which has also been added the products of the Great Lakes Forge Company of Chicago, recently purchased.

The American Manganese Steel Division has six plants throughout the country, the largest of which is located at Chicago Heights where Mr. Black is located.

President Roberts of Athey Truss Wheel Company Dies Suddenly

Mr. James A. Roberts, President of the Athey Truss Wheel Company, died in Cheyenne, Wyoming, Saturday, October 12th, 1940. Mr. Roberts was returning to Chicago after an extended business trip when suddenly stricken with appendicitis and taken to a hospital in Cheyenne, where he died following an operation.

Mr. Roberts leaves a brother George, who has been associated with the Athey Company since its formation in 1922. He had a host of friends in the construction industry and particularly in the road building field.

Ozalid Corporation Merged with General Airline

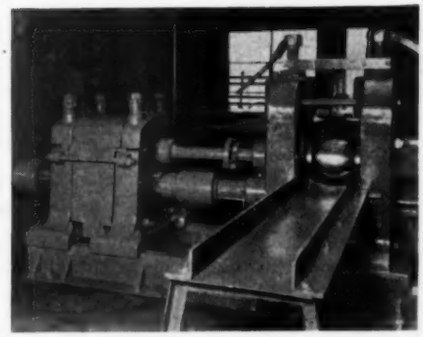
The Board of Directors of Ozalid Corporation have announced that as of September 30, 1940, this Corporation was merged with its parent organization, the General Aniline and Film Corporation of 230 Park Avenue, New York, N. Y., and that business is now conducted as General Aniline and Film Corporation, Ozalid Products Division, with Sales and General Offices in Johnson City, New York. There will be no change in the Ozalid management or personnel.

New Equipment Installed by Tuthill for Manufacture of Guard Rail

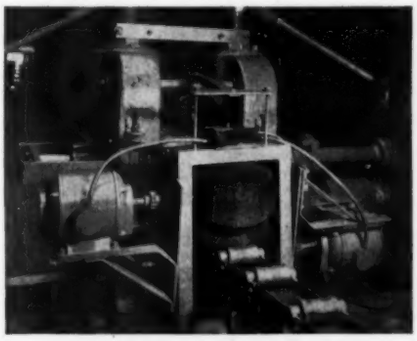
New equipment especially designed and constructed for the manufacture of convex highway guard rail has recently been installed by the Tuthill Spring Company of Chicago.

Material for the rail is brought from the steel mills in hot-rolled strips, 12⅝ inches wide x No. 9 gauge. After it is received at the plant, each strip, or panel, is punched with four holes at one end and four slots at the other.

The panels are then formed in a special roll stand, which gives them their convex shape. The first picture shows the entering side. On coming from the forming rolls, the panels pass between two steel wire brushes, which take off all loose scale, leaving the surfaces in proper condition for a prime coat of red or blue lead paint. Picture No. 2 shows the brushes, the dust hood and ex-



Rolls and Main Motor of the New Guard Rail Forming Machine



Discharge End of the Machine, with Dust Hood Removed to Show the Brushes

KNOCK DAYS OFF EVERY JOB!

- Road Work
- Excavating
- Cut and Fill
- Landscaping
- Construction
- Repair Jobs

Brooks LOAD LUGGER is a time-saver in hauling materials wherever loading is done by hand . . . as shown in a typical scene above. The men fill the empties while the Load Lugger carries away and dumps the loaded buckets. No waiting . . . no idle equipment . . . no exhausting work for the men, as they can shovel material at knee level. Write for Bulletin, showing many cost-cutting applications.

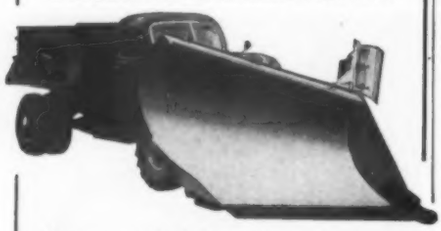
Ask about our Special Introductory Offer of a Free Trial of the Brooks LOAD LUGGER.

Brooks EQUIPMENT AND MFG. CO.

KNOXVILLE 511 Davenport Road TENNESSEE

Distributors in all Principal Cities

There's a Difference



Between "bulldozing" and plowing snow; bulldozing is merely pushing the snow which takes plenty of power, while plowing snow picks it up and rolls it. That is why Ross PLOWS with "Sno-Flo" moldboards will move more snow with fifty percent less power.

Ross plows have gained an enviable reputation in the snow belts of the United States and Canada because of operating efficiency.

Ross plows and wings are available for all trucks and tractors.

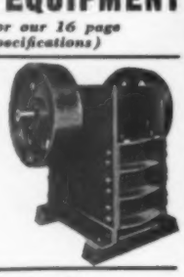
Manufactured by

THE BURCH CORPORATION
Crestline, Ohio
Builders of Equipment for Fifty Years

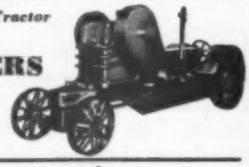
"Established in 1885"

For LOW COST LARGE PRODUCTION
you can depend on
GRUENDLER EQUIPMENT
(FREE—Write for our 16 page Catalog and Specifications)

JAW CRUSHERS
Bronze or Roller Bearing
Heavy armor plate steel or cast steel.
Heavy Duty Construction
Large capacity
Small power Requirements



Self Traveling Tractor
JAW CRUSHERS
Ideal for maintenance road work



Stationary or Portable
LIMESTONE CRUSHERS
Wide crushing range, crushes stone 2½" down to agriculture dust.
Ideal for Farm to Market Road Work
Portable 2 in 1 Hammer Crushers

GRUENDLER
CRUSHER & PULVERIZER CO.
2921-29 N. Market St., St. Louis, Mo.

haust equipment having been removed in order to show them.

The forming rolls are driven by a 75 H.P. electric motor. Operating speed is 200 feet of panel per minute. The roll pressure is approximately 30 tons. Each brush is operated by its own independent motor, as shown in the picture. Normal capacity per 8-hr. day is 2400 panels, or 30,000 lin. ft.

G. S. Swanson Is Cleveland District Sales Manager for Williams Buckets

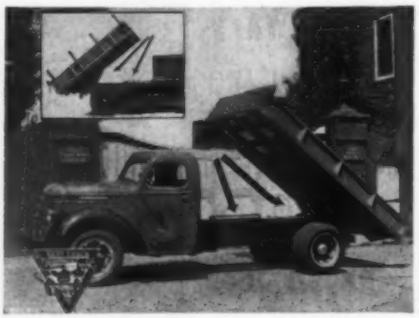
"Gus" Swanson

The Wellman Engineering Company, Cleveland, Ohio, announces the appointment of Mr. G. S. (Gus) Swanson as Cleveland District Sales Manager of WILLIAMS.

Mr. Swanson, for the past several years, has been associated with the Pettibone - Mulliken Corporation, Chicago, but is an old-timer with WILLIAMS buckets. He was employed by the G. H. Williams Company, Erie, Pa., prior to Wellman's purchase of the Bucket Division about nine years ago.

An Old-Timer Still on the Job

Seventeen years ago, a Gar Wood cam and roller hoist was installed on a Lange chassis, shown in inset, for the Lange Motor Truck Company (now non-existent). This hoist has been in use since that time. Recently, this same hoist was installed on a 1940 model D-30 International chassis, 155 in. wheelbase with a special 144 in. body,



That Old Gar Wood Hoist

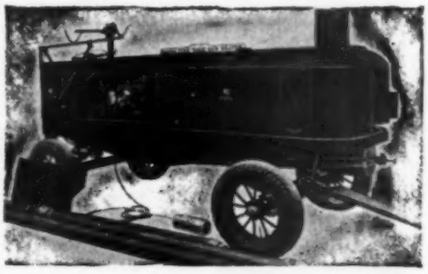
shown above. The only additional work necessary to remount this hoist was a new power take-off and two wooden sills, according to A. M. Hauber, President of the Auto Truck Equipment Company—oldest Gar Wood distributor—of Pittsburg, Pennsylvania, who made the installations, stated W. H. Hammond, sales manager of the Hoist and Body Division of Gar Wood.

New Appointments by Robins Conveying Belt Co.

The Robins Conveying Belt Company, Passaic, New Jersey, makers of material handling equipment, have completed the reorganization of their advertising department. Mr. H. Von Thaden, vice-president and sales manager of the company, has announced the appointment of Mr. Alfred S.

GRACE 2-WAY AXLE DRIVEN SWEEPER

RAPID FIRE HEATER



- ***Grace 2-Way Axle Driven Sweeper***—**the modern traction driven sweeper that successfully meets every problem of any contractor.**
- ***Rapid Fire Heater***—**A fast-pumping, fast-heat circulating heater that heats 10,000-gallon insulated cars at 50° per hour. Write for detailed information and prices.**

W. E. GRACE MFG. CO. 6000 Holmes St. DALLAS

HUSTLE WITHOUT BUSTLE

We're hustlers when the occasion demands but we don't make any noise about it. Our service is as cheerful and quiet as it is speedy.

Emil Eitel
Karl Eitel
Roy Steffen

BISMARCK HOTEL-CHICAGO
RANDOLPH AND LA SALLE

Otton as advertising manager. Mr. Otton will be assisted in his new duties by Messrs. E. E. Riches and John M. Lupton.

The new advertising manager, Mr. Otton, has been associated with the Robins Company since 1937, having recently been in charge of all screen cloth sales. He was formerly associated with the late Mr. William L. Fewsmith who for many years was the company's director of advertising and publicity. Mr. Riches has been connected with both the engineering and preliminary design departments of this company for many years. Mr. Lupton comes to the company with a wide background of experience in advertising and printing.

Last May, the Robins Conveying Belt Company moved its general offices from 15 Park Row, New York City, to a new administration building at Passaic, New Jersey, where for many years its factories have been located. The company manufactures a complete line of belt conveyors, idlers, vibrating screens, feeders, grab buckets and other material handling equipment.

R. D. Holcomb Becomes P&H Sales Manager

The Harnischfeger Corporation of Milwaukee announces the appointment of Mr. R. D. Holcomb as sales manager of this firm's large excavator division. This division includes machines of capacities from 1¼ cubic yards to 5 cubic yards. Mr. Holcomb was formerly district manager of the Harnischfeger Memphis territory. He will be succeeded in that capacity by Lee M. Cauble.

New Link Belt Speeder Distributors at Pittsburgh and Tulsa

Link-Belt Speeder Corporation, Chicago, announces the appointment of the J. W. Patterson Company, Pittsburgh, Pa., as authorized distributor for the complete line of Speeder and Speed-o-Matic shovels, draglines, cranes, ranging from a fast, mobile ⅜-yd. unit to a heavy-duty 3-yd. machine.

Tulsa Machinery Company, Tulsa, Oklahoma, will handle the same line in their territory.

Both these distributors thus have available a full line of all types of convertible shovels, draglines, cranes, pull shovels, including both crawler and truck mounted units.

Marmon Herrington Expands Plant Twice in Three Months

A building program, which doubled the capacity of the Marmon-Herrington plant at Indianapolis has just been completed, and now the company is starting a further plant expansion of approximately equal magnitude. Additions to the already greatly enlarged truck and tractor assembly plants and to the office building as well as a new service building are now under construction. Starting from scratch less than ten years ago, the company's plant site now comprises 16 acres of ground, with numerous buildings and private railroad facilities. "The Marmon-Herrington Company is the logical outgrowth of experience gained in the World War, where A. W. Herrington, the president of the company, held an important post in the motor transport corps of the A. E. F." says a company official.

New Sullivan Distributor in Control of New York

The E. T. Credle Equipment Company, 1313 Seymour Avenue, Utica, New York, has been appointed distributor for Sullivan Machinery Company. They will handle Sullivan air compressors, rock drills, drill steel sharpeners and furnaces, concrete breakers, spaders, portable hoists, pavement testers and accessories for contractors, public utilities and government highways in Madison, Oneida, Herkimer and Lewis Counties in New York State.

George W. Malcomson Is Assistant Sales Manager of Dodge Truck Division

Appointment of George W. Malcomson as assistant sales manager of the truck division, Dodge Brothers Corporation, was announced in October by Lee D. Cosart, truck sales manager. For two years prior to his present appointment Mr. Malcomson was Chicago regional manager for Dodge. A native Detroiter, he joined the Dodge truck sales organization in the special equipment division in 1930. Subsequently he was associated with the factory truck sales promotion and advertising departments and in 1933 was appointed truck representative in the Detroit and Chicago regions. In 1934 he was named Chicago city manager and in 1936, became regional manager at Atlanta.

Geo. W. Malcomson

Shell Oil Co. Names David Waxman Head of Asphalt Department

David Waxman has become manager of the Shell Oil Company's asphalt department, Alexander Fraser, president, announced late in October.

Mr. Waxman's appointment was made a part of the current move to consolidate the company's entire organization. Merger of Shell's eastern and mid-western marketing and producing units is being accomplished.

He has been with the Shell company for more than fourteen years. After graduation from the University of Pennsylvania in 1919, as a civil engineer, Mr. Waxman went to work for the state highway department of Pennsylvania. Later he was employed by the construction division of the United States Army, and the Pittsburgh testing laboratories in Birmingham, Ala. For a little over a year, beginning at the end of 1924, he was engineer and superintendent for Sam. E. Finley, Atlanta contractor, in charge of building asphalt roads.

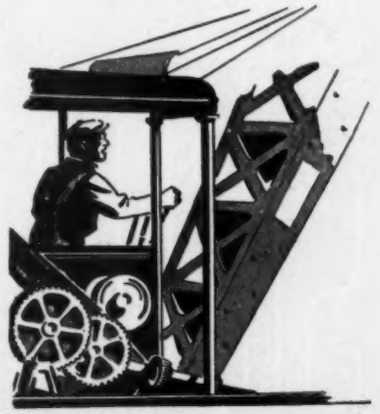
Mr. Waxman entered the employ of the Shell company in New Orleans, as asphalt salesman, in 1926, working his way up to manager of the St. Louis office in 1929.

"FAR AHEAD OF BUCKETS WE HAVE USED IN THE PAST"

● M. F. Quill & Son, Cincinnati, Ohio, are using a Williams ¾ Yard Multiple Rope Bucket for excavating and material handling. They write: "We are extremely well satisfied with the performance of this bucket and much impressed with your new welded construction. We feel the design, construction and materials are far ahead of any of the competitive buckets we have used in the past."

You, too, will find Williams digging speed and durability a big factor in producing profits. Tell us the type of service you are interested in and we will send free, individual bulletins giving complete information.

The Wellman Engineering Co.
7003 Central Avenue
Cleveland, Ohio



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NOVO BREAKER

PAVEMENT
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The results obtained with the Novo Breaker in breaking up pavements, bridge floors, drives, curbs, etc., have proved beyond a doubt that here is the fastest, cheapest breaking method.

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Hammer equipped with shearing knife is used for trench work, cutting without breakback in reinforced concrete. Also used in frost & trimming.

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Let us tell you the surprisingly low cost figure at which pavements can be broken by this method. It mounts on your truck. Send for information.

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NEW TRADE LITERATURE

Pictures Tell Money-Making Story for ½ to ¾ Yard Shovels—With 67 photographic illustrations, bulletin No. 2066 just released by Bucyrus-Erie Company tells the on-the-job story of ways in which contractors are making money with the versatile ½-yard to ¾-yard shovels which have become so popular. Virtually every phase of excavating, grading and dirt-moving operations is represented. The machines are shown operating as shovels, dragshovels, skimmers, draglines, clamshells and cranes on a wide range of actual jobs. Copies of the new bulletin are available on request from Bucyrus-Erie Company, South Milwaukee, Wisconsin.

Pioneer Traveling Grizzly Feeder—Pioneer Engineering Works has issued an illustrated, letter size 4-page bulletin describing its traveling grizzly feeder. Diagrams and general specifications are included.

Street Signs—A 16-page booklet has been issued by the Municipal Street Sign Co., Inc., 777 Meeker Ave., Brooklyn, N. Y. It shows all the different types of street signs manufactured by the company, including some of the latest developments in street name signs.

Dustlaying With Calcium Chloride.—A new booklet entitled "End Dust and Weeds" has been issued by the Solvay Sales Corporation, 40 Rector St., New York, N. Y. This book explains what calcium chloride is—how it works—how it is used. It includes information on quantities to use per square yard of surface treated, and describes the advantages of the calcium chloride treatment for large as well as small areas. Full-page photographs illustrate the places where calcium chloride can be used. These range from paths to playgrounds, from parking spaces to roads.

Carryall Scraper Booklet. In a new 8-page booklet recently released by R. G. LeTourneau, Inc., manufacturers of earthmoving equipment, Peoria, Illinois, the factors that determine selection of large Carryall Scrapers are presented in interesting pictorial form.

Carryall Scraper sizes from 15 to 33 yard capacities are shown on various large scale construction jobs, including the Pennsylvania Turnpike. The advantage of using large scraper sizes are pointed out and suggestions for supplementing scrapers with other LeTourneau equipment are shown. It is further pointed out that the use of an extra tractor for push-loading these large capacity scrapers will result in yardage gains which result in lower earthmoving costs.

Largest of all tractor-drawn scraper units—a 33-yard capacity Carryall—is shown in actual operation.

Copies of this new publication may be obtained by writing the manufacturer, requesting Bulletin A-014, or by contacting LeTourneau—"Caterpillar" dealers.

Hose, Belting and Other Mechanical Rubber Items. Catalog No. 207, just issued by Goodall Rubber Co. (address on request), contains 68 letter-size pages of data and illustrations covering approximately 275 brands and specifications. 74 of these are new additions that were not covered in former catalogs. Complete tabular data including weights are given for 58 items. Most of the other products have partial tabular data. There are 7 basic price lists and 3 pages of technical tables. A classified index at the beginning of the book is of much practical value. A heavy transparent cover adds umph to an already attractive book.

New SKF Catalog—SKF Industries, Inc., manufacturers of ball and roller bearings, has just released an attractive 36-page catalog entitled "Spherical Roller Bearings." The first 20 pages of this bulletin are devoted to illustrations of roller bearing applications in mining, crushing, steel, paper. oil, railroad, and allied fields. The remainder of the book contains helpful information on bearing selection, timesaving computations, and drawings of various types of roller bearing design.

New Emulsified Asphalt Specifications—Construction Series No. 53, "Specifications for Emulsified Asphalts," as adopted by the Asphalt Institute, September 11, 1940, are now available. Requests for these specifications. as well as for Construction Series No. 51, "Revised Specifications for Cutback Asphalts," and Construction Series No. 52, "Revised Specifications for Slow-Curing Liquid Asphaltic Road Materials," should be addressed to The Asphalt Institute, 801 Second Avenue, New York City, N. Y. No charge is made for any of these publications.

Concrete Mixers and Equipment.—Bulletin No. 167 issued by Ransome Concrete Machinery Co. (address on request) gives a birdseye of their entire line of mixers, pneumatic placers, buckets, carts, bins, towers, mast plants, etc.

Conveyor, Crusher, and Miscellaneous Equipment Catalog—The C. O. Bartlett & Snow Company is starting the distribution of its new No. 90 General Catalog, replacing the former No. 50 and No. 74 catalogs. The new book—372 pages—gives complete details of Bartlett-Snow elevators and conveyors, chains and sprockets, crushers, gates and miscellaneous equipment.

Covers Simplex Jack Line—A new 60-page Junior Catalog designated No. 40, that readily fits into the vest pocekt, has just been issued by Templeton, Kenly & Co. (address furnished on request). It fully describes the construction, application and gives specifications for the 300 plus sizes and types of Simplex Jacks. There are over 100 illustrations. Simplex Automatic Raising and Lowering Jacks, Screw Jacks, Journal Jacks, Geared Jacks and the more specialized jacks for various industries such as mining, oil, utilities, railroad, aircraft. construction and marine are covered.